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VOLUME, 109, NUMBER 14

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Published every Thursday. Price 25c. per copy. Subscription, domestic, Central and South America, $5 per year. Canada, including duty $7.50. Foreign $9 or 45 shillings. Entered as second-class matter at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable Address "MCGRAWHILL, New York." Member A.B.P. Member A.B.C.

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.; Los Angeles. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; Edgar Kobak, Vice President; H C. Parmelee, Vice-President and Editorial Director; Harold W. McGraw, Vice-President; C. H. Thompson, Secretary.

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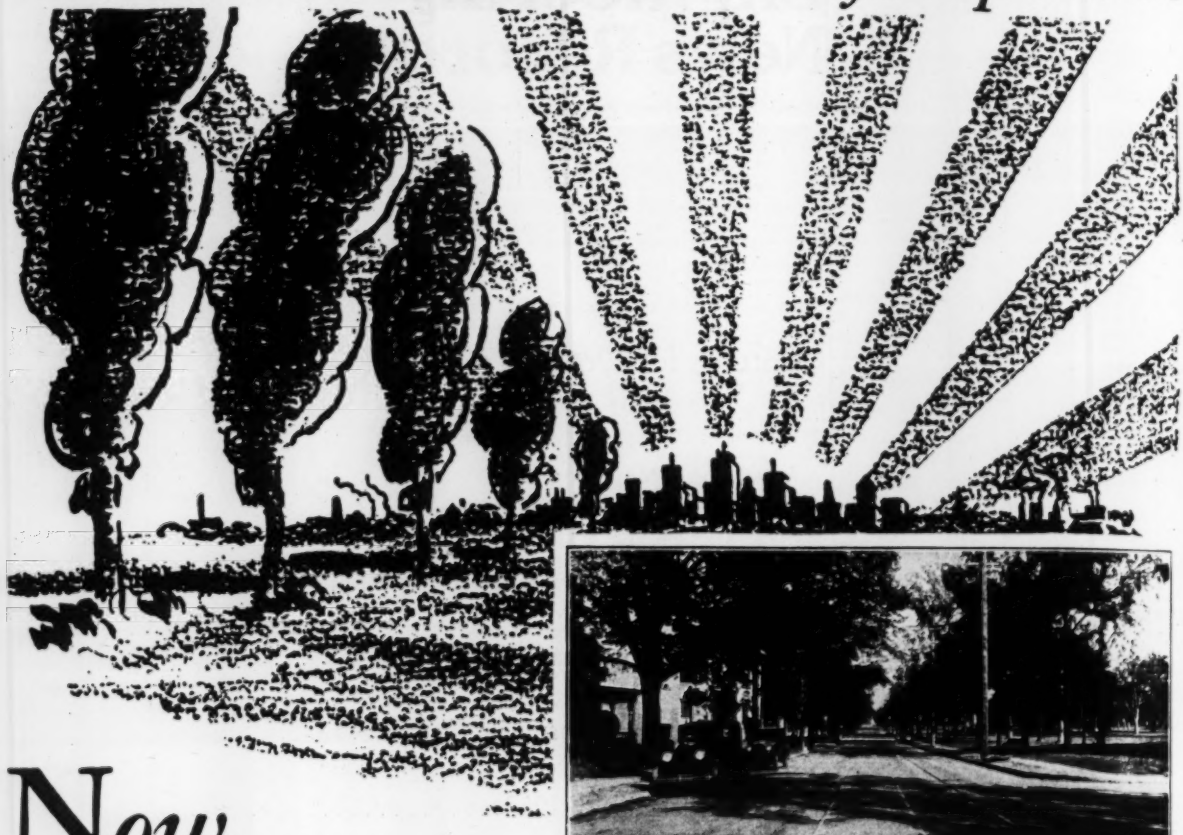

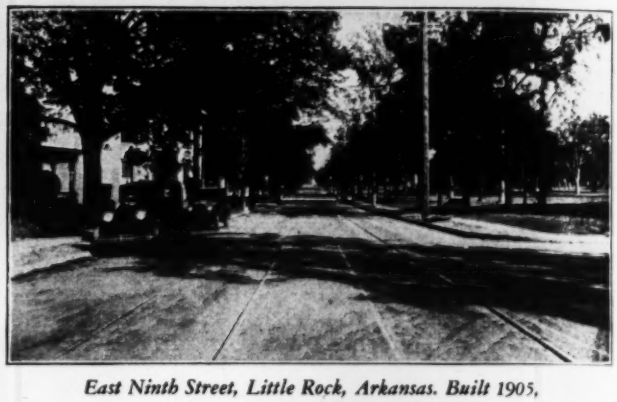

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Clay Grouting at Madden Reservoir

Field and laboratory experiments show feasibility of making cavernous and fissured rock ridge inclosing new Panama Canal reservoir impervious by injecting clay slurry

By F. H. Kellog

Associate Geologist, Panama Canal 1929-32; Geological Laboratory, Johns Hopkins University, Baltimore, Md

DURING the preliminary investigations of the Madden Dam project, one of the causes of gravest concern was the permeability of the impounding ridges of the reservoir. This was due to the cavernous nature of the limestone which forms the narrow, downstream sections of the ridges.

In the geological report on the feasibility of the project,[1] recommendation was made that the proposed flow line elevation be reduced in order to minimize the danger of breaches in the ridges due to increasing underground leakage. However, a maximum flow line elevation of 263 and an operating level of 240 were considered essential for the purposes of the project,[2] and it therefore became necessary to determine a means of safeguarding the reservoir at these elevations.

Cement grouting was deemed impracticable for this work, because of the presence, in caverns and crevices, of a lining of loamy sand with which the cement would not bond. Local conditions indicated that considerable expense would be involved were asphalt grouting to be undertaken. The proximity of large quantities of clay led to the suggestion, by the board of consultants, that this material be used as a grouting medium.[3] The writer was assigned the problem of determining the feasibility of this suggestion and of developing a suitable grouting procedure.

Fig. 1—Cavern of larger size in rim rock surrounding Madden reservoir. Note joints or parallel fissures opening into cavern.

The only reference found in the available literature to any similar use of clay was that describing the tamping of clay into a spring with a pile driver at New Croton Dam.[4] A series of experiments was therefore initiated to study the properties and efficacy of clay as a grout.

The general procedure to be tested was that of puddling clay with sufficient water to cause ready flow, injecting the mix under pressure and subsequently squeezing sufficient water from the clay to render it highly

impervious and at the same time resistant to underground erosion. The tests included direct observation underground, of the effects of experimental grouting; grouting on a larger scale through exploratory drill holes, and laboratory tests of the properties of the clay used. A description of the rocks in which these tests were performed may be found elsewhere.[5]

Direct observation

The objects of this group of tests were: (1) to determine what type of clay mix would make the best grout; (2) to note the distances through which the grout would travel underground; (3) to note the sizes and types of openings in the rock that could be grouted, and (4) to check the efficacy of the methods used in stopping leakage. The experiments were performed at a place where the effects of grouting could be observed underground in a cavern. Fig. 1 shows one of the caverns, with joints or series of parallel fissures opening into it. Fig. 2 shows some of the underground openings.

Tests were made on grout holes drilled so as to intersect joint planes at known distances from their outcrops in the cavern. The injection apparatus consisted of an 11-cu.ft. steel tank with valve connections to an air compressor, feeding the grout to the drill holes through a 1-in. pipe line. Samples of the clay to be used were taken for laboratory tests which would serve to describe the clay. Mixing with water was by hand and the grout was screened to eliminate lumps and rock fragments. Samples of each mix were taken and sealed in water-tight containers to be tested for moisture content. The admixture of small quantities of cement was tried, to check its value in decreasing shrinkage. Blow-outs of grout were immediately sealed wherever possible. Two holes were drilled so as to miss intersection with known joints by 3 ft., to test the ability of clay grout to travel through rock pores. Air pressures of 50 to 110 lb. per sq.in. were used, these pressures being held for 24 hours after grouting had been brought to the point of refusal. Grouted holes were subjected to water-pressure tests at pressures of 110 lb. per sq.in.

The results of these experiments indicated that a pure clay-water mix would serve best. The use of cement in quantities sufficient to affect the shrinkage not only caused undesirably rapid setting but formed a sort of artificial clay-sandstone which, while of low permeability, would offer little resistance to underground erosion because of the loose cementation.

Grouts containing less than 48 per cent water by weight could not be forced through a 1-in. pipe under a pressure of 100 lb. per sq.in. The significance of this and the following moisture contents given is discussed below, under the heading Laboratory Tests. Grouts containing more than 60 per cent water by weight, which had been used in the hope of forcing them through porous zones in the rock, were too thin to be of value. The best results were obtained with grouts containing about 55 per cent water. The minimum distance underground through which grouts of this consistency were seen to flow was 13 ft. The maximum distance observed was 50 ft. Grouts containing about 55 per cent water were found to penetrate seams with widths as low as $\frac{1}{2}$ in.

Fig. 2—Smaller cavities, fissures and underground openings in rim rock surrounding Madden reservoir.

No grout could be forced through pores in rock or through the loamy fill material along the joint walls. The water-pressure tests on those holes which had been grouted to refusal were generally satisfactory. The rate of flow of water under an air pressure of 110 lb. per sq.in. through an incompletely grouted hole was 59 cu.ft. per minute. Through grouted holes, the rate was from 1.89 to 5.18 cu.ft. per minute. Through one of the holes which had been drilled 3 ft. short of intersection with a known joint and which had taken only enough grout to fill the volume of the hole, the flow was 0.22 cu.ft. per minute. During the pressure-testing of grouted areas, where grouted seams were visible, water could be seen dripping out of the pores of the rock near the seams, but at no place was any water seen escaping along a seam.

During injection of grout it was noticed that the clay was carried by the air in a rather fine spray. This spray would hit the walls of the joints with a terrific impact, causing a very noticeable loss in water content. Apparently, this spraying of grout facilitated the entrance of the material into the smaller seams, and accelerated subsequent consolidation.

Drill-hole experiments

Having established the feasibility of the use of puddled clay as a grouting medium, it now became necessary to determine what actual conditions would be encountered in application. An estimate of the quantities of grout involved a plant capable of mixing, transporting and injecting these quantities within a reasonable time, and data upon which cost estimates could be based were required. Information on these points was obtained by grouting some of the 3-in. exploratory drill holes in the area under consideration.

In estimating the amount of clay likely to be required in the areas to be grouted, a rough theoretical calculation was made which was checked against the actual quantities taken by the exploratory drill holes. Using figures obtained from measurements of 600 joints and assuming the maximum spread of grout to take place in the largest joint set, assigning proportionately reduced distances of spread for the smaller sets, the volume of voids due to joints was calculated. The volumes of known caverns, as determined from actual measurements, were added. Calculated quantities were checked against actual amounts of grout injected. In this manner, it was estimated that 18,000 cu.yd. of clay would be necessary to complete all this work in about twelve months, in order to allow the construction of saddle dams or dikes across low parts of the impounding ridges to proceed unhindered. Hence, a rather large plant

would be required. Design of such a plant involved the three problems of mixing, transporting and injecting, which will be treated separately.

No simple rotary motion can be considered in the mixing of clay and water, since the clay would merely ball up and stick to the blades of the mixer. Any mixing process requires considerable shearing and crushing to break up the clay and permit the water to enter it. Hand mixing is slow and requires rather long periods of soaking of the clay in water before it can be puddled successfully. From inquiries made, it is apparent that the blunger used in the ceramic industry for mixing clay and water would serve the purpose. The clay would have to be prepared for the blunger by a disintegrator. These machines are described in the catalogs of the various manufacturers of clay machinery. During the writer's association with the work at Madden Dam, a hand-mixing plant produced the bulk of the grout, pending the installation of a mechanical mixer. This plant required five men for operation and had a capacity of 35 cu.yd. per eight-hour shift.

Screening of the mixed grout is desirable since this removes the lumps and rock fragments always present, facilitating the pumping of the grout and increasing its spread underground. The most convenient screen sizes for this work are 1-in. mesh and 4-mesh. Passing the grout successively through the two sizes reduces the tendency of the clay to clog the screens. The screen should be made of fairly heavy wire. During experimental grouting it was found that wire smaller than 10-gage would wear out in very little time. Stationary screens were used in the work at Madden Dam, and these required almost constant raking. The use of a centrifugal screen was tested by an improvised model made from a blower, and such a screen was recommended.

Obviously, the most desirable system of grouting with clay would be to pump all grout from a central mixing plant to the drill holes. Two factors might be considered drawbacks to such a system (1) abrasion of various parts of the pump by the grout, due to a sand content in the clay and (2) loss of pressure due to friction.

During the experimental grouting of exploratory drill holes, a double-acting piston pump driven by a 7-hp. gas engine was used. The only way in which this pump could be made to serve the purpose was by protecting the hard rubber disk valves with steel plates, about ⅛ in. thick, riveted into the rubber, and by using case-hardened steel valve seats, stems and sleeves. For actual grouting, a double-acting piston pump with gravity inlet, steel ball valve at the outlet and air driven was recommended. This pump can produce pressures up to 150 lb. per sq. in.

Loss of pressure due to friction was studied by running grouts of various fluidities through 100-ft. lengths of 1-, 2- and 3-in. galvanized iron pipe at various velocities. Pressure loss was measured by steam gages, the pressure of the grout being transmitted to the gages through columns of water. Velocity was calculated from rate of flow, which was measured by placing containers of known volume at the discharge ends of the pipe lines and taking with a stop watch the times required to fill them. Samples from these containers were taken and placed in water-tight cans to be tested for viscosity and density. Pressure was applied from a steel tank connected to an air compressor. The results obtained were applied in the exponential formula for loss of head given by Scobey.* This shows that for the particular clay tested, if H = loss of head in ft. per 100 ft. of pipe; v = kinematic viscosity, in centipoises; V = linear velocity, ft. per sec.; and D = diameter of pipe in ft.,

$$H = \frac{0.21 v^{0.35} V^{1.75}}{D^{1.25}}$$

Application of this formula shows that the high-velocity grout injection involved in the use of air would prohibit placing the injection tanks at the central plant. The low velocities attained with a piston pump, however, permit pumping the grout through long pipe lines to the drill holes, even in the cases of very viscous grouts.

Since thinner grouts more readily enter the smaller seams, and since air injection facilitates the removal of water from such thin grouts, this type of injection was used for the first stages of grouting in any drill hole. The subsequent treatment was varied according to the amount of back pressure noted during this first injection. For example, pressures of 85 to 100 lb. per sq.in. during injection called for the use of grout containing about 55 per cent water by weight, and air injection. Pressures of 50 to 85 lb. per sq.in. required that resistance be built up by the use of thicker grouts, varying from 50 per cent down to 45 per cent water. Pressures of less than 50 lb. necessitated the use of very thick grout, the moisture content of which would be reduced gradually, down to as little as 43 per cent.

Maximum quantities of grout to be injected at each moisture content and pressure were assigned arbitrarily, except that no grout with less than 43 per cent water was used. All grouts of less than 50 per cent moisture were injected by piston pump. All drill holes were made to refuse grout of at least 45 per cent moisture at a pressure of 100 lb. per sq.in. They were then made to refuse grout of at least 47 per cent water content at 150 lb. pressure. Any sudden pressure drop was compensated by immediate injection of thicker grout. Blow-outs at the surface were sealed by cement if they occurred in solid rock, or by tamped clay if they occurred in weathered rock or soil. Finally, pressure would be applied up to 300 lb. per sq.in., using an hydraulically operated ram and grout of 50 per cent moisture or more to transmit the pressure. A hole refusing at 300 lb. would be capped by closing a two-way cock with the pressure still acting. Hence, the procedure consists of injecting the thinnest grout that produces pressure resistance, and in the case of low resistance, indicating large underground void spaces, gradually increasing the pressure by the use of thicker grouts. Were thicker grout used initially, filling of smaller seams would not be effected.

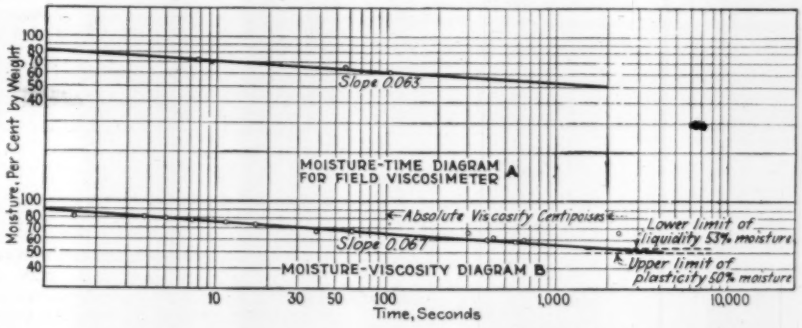

Fig. 3—Moisture-viscosity and moisture-time diagrams of clays of different moisture content as determined in the laboratory.

Two 11-cu.ft. steel tanks, connected to an air compressor and fed with clay from the mixing plant by gravity through a 6-in. pipe line, were used for air injection. The tanks were placed near the holes being grouted. The pump previously recommended was used for all grouts of less than 50 per cent moisture. For pressures of more than 150 lb. per sq.in., a hydraulically operated ram, placed at the mixing plant, was used. The maximum quantity of grout injected under these conditions, in any single 8-hr. shift during the writer's association with the work, was 70 cu.yd., using two mixing units.

The tests of clay which were made in the laboratory may be grouped into (1) tests made to describe the clays,

and (2) tests made in conjunction with field experiments.

Tests chosen to describe the clays give information as to the relation of moisture content to the consistency of the clay, the proportion of clay likely to go into solution or suspension, the organic content, the grain sizes, the relative time-rate of consolidation and the relative permeability.

An idea of the relation of the moisture content to the consistency of the clay is necessary to understand the significance of the figures given in the preceding discussion of field experiments. The moisture percentages there given hold true only for the particular clay used. To compare this and other clays, it would be necessary to compare their respective lower limits of liquidity and plasticity and the densities of their grains.[7] The lower limit of liquidity of the clay used is at the moisture content of 90 per cent, expressed in per cent of the weight of dry material. The lower limit of plasticity is about 35 per cent and the shrinkage limit is 22 per cent. The specific gravity of the grains of this clay is about 2.7.

Solubility tests were made by agitating clay samples in water, allowing the clay to settle and evaporating the supernatent liquid. Ignition of the residues gave the amounts of organic matter in the dissolved solids. The total amount of carbon in the clay was also determined, allowing for that due to carbonates.

The grain size was determined by mechanical analysis according to the procedure descrbied by N. B. Stearns.[8]

Information on the relative time-rate of consolidation and the relative permeability was obtained with such equipment as was available, following the procedure of Terzhagi for the "standard compression test."[9]

The tests made in conjunction with field experiments were determinations of moisture content and viscosity.

Moisture contents were used as gages of the fluidity of the grout. In the field they were always expressed in percentage by weight. Had percentage of the weight of dry material been used the viscosity-moisture diagrams, the application of which is explained below, would have shown as assymptotic curves which would have been useless for field purposes. To determine the moisture content in the field, a workability meter was used. This consisted of a 1-ft. section of 1-in. copper pipe into one end of which was welded a bronze plug 2 in. long. A hole $\frac{3}{16}$ in. in diameter was drilled into this plug. The first and last half inches of the hole were widened gradually to a maximum diameter of $\frac{1}{2}$ in. The tube was filled with a clay-water mix of known moisture content and the time required to empty it by gravity through the hole in the plug was taken with a stop watch. The times of flow of a number of mixes at different moisture contents were taken in this manner. The results were plotted on logarithmic paper, as shown in *A*, Fig. 3. A separate diagram was required for each different type of clay. A graph for the clay being used would be sent to the field, where grouts taken from the mixer could be run through the tube, timed, and the moisture content corresponding to the recorded time read from the diagram.

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Measurements of viscosity were made in conjunction with the tests for determining the pressure loss due to friction involved in pumping grout through the pipe lines. In the case of the clay used in making the diagram of Fig. 3, mixes with less than 57 per cent water could not be passed through the Saybolt viscosimeter. Mixes of 57 to 81 per cent were tested, the results being expressed in centipoises. Absolute viscosity was plotted against moisture content on logarithmic paper, as shown in *B*, Fig. 3. Since viscosity is, by definition, a function of velocity, which is in turn a function of time, the slopes of lines *A* and *B* in Fig. 3 should be identical. The actual difference obtained is only 0.004. The viscosity of grout of less than 57 per cent was obtained by running the moisture content and reading the corresponding viscosity on the moisture-viscosity diagram for the clay tested. Kinematic viscosity, for use in the pressure-loss formula, was obtained by determining the mean density of the grout and dividing the value of the absolute viscosity by this figure.

GROUTING COSTS AT MADDEN RESERVOIR

Item	Quantity	Unit Cost
Drilling 3 in. holes...	2,200 lin.ft.	$0.566 per ft.
Drilling 7 in. holes...	800 lin.ft.	1.00 per ft.
Pipe in grout holes..	1,840 lb.	0.555 per ft.
Pressure grouting....	504 cu.yd.	4.86 per cu.yd.
Filling large caverns*	2,000 cu.yd.	1.25 per cu.yd.

*Exclusive of excavation and installation of cut-off walls underground.

Actual grouting results

Actual grouting at Madden Dam is now under way, using a procedure based upon the results of these experiments, and the operations have given some indications of the success of the work. An idea of the results can be gained (1) from the action of wash water during drilling of test holes through a partially grouted area, and (2) from direct observation of grouted seams made while digging pits at surface blow-outs for the purpose of sealing them with tamped clay.

As an example of the former, let us consider the case of exploratory drill hole L-32. This hole had been drilled about a year before any grouting was commenced. It was to be deepened 60 ft. and used as a test hole for studying the efficacy of the grouting. During the orignial drilling of the hole, wash water had been lost at elevation 255, a distance of 44 ft. below the collar of the hole. Just before the subsequent deepening the hole had been washed out to remove cuttings and caved material. During this washing, grouting was in progress nearby. A return of water was gained, the water finally becoming clear. As additional drilling was commenced, the wash water continued to return although it was being shot through a $\frac{1}{8}$ in. opening under a pressure of 100 lb. per sq.in., giving a strong nozzle effect. The wash water finally disappeared at elevation 175.

During excavation of small pits at the sites of surface blow-outs, several well-grouted seams were observed in a highly weathered and leached rotten limestone. The clay in the seams had reached a moisture content below that of its lower limit of plasticity. Its bond with the country rock was perfect.

Filling of the very large open caverns was effected by mixing clay and water quickly, with none of the refinements used in mixing grout, and running the mix down 7-in. drill holes by gravity. To fill voids caused by shrinkage, pressure would be applied by the hydraulic ram at a later time. The high pressures would be applied both to the 7-in. and to the 3-in. drill holes. The latter also served to check the flow of clay in the caverns.

The accompanying table gives a resumé of the costs as they are known to the writer. Since these costs are based chiefly upon experimental work, they are probably much higher than those of the subsequent large-scale operations. The grouting costs, however, are much lower per unit of volume than the costs of cement grouting on other parts of the same project.

Conclusions

Puddled clay, used as a grouting medium, may be employed to form underground cut-off walls of compact clay

in rocks containing void spaces of considerable magnitude. It is especially applicable to use in cavernous limestones, where suitable clays are common as weathering products of the country rock. It does not seal the rock so perfectly as do cement or asphalt grouts, nor will it enter small void spaces such as rock pores, as will cement in the Francois process, but it may be employed where none of these other grouting procedures would be practicable. It is considered capable of reducing dangerous leakage to harmless seepage.

The advantages of the process described are (1) low unit cost of large-scale grouting, (2) large amount of grouting that can be done with a single drill hole, (3) possibility of controlling the time of setting by pressure application, and (4) practicability in grouting highly weathered rocks.

Possible objections to the procedure are considered to be (1) low resistance of the clay to erosion or disintegration, (2) possible difficulty in obtaining pressure resistance because of surface blow outs, and (3) impossibility of grouting openings already filled with running water. The first objection becomes insignificant where groundwater is under low head, as under reservoir ridges or low impounding structures. The clay, of course, must be low in colloids. Its permeability is decreased by the resistance of joint or cavern walls to swelling, so that there is less chance for disintegration. The second objection can usually be eliminated by sealing blow outs with cement or tamped clay. Both types of seals are capable of resisting the pressure of final refusal.

The experiments on the work were made possible by the recommendation of Maj. J. C. Mehaffey, assistant engineer of maintenance, Panama Canal. The writer is indebted to E. S. Randolph, designing engineer, Madden Dam, for aid and suggestions during his supervision of this work.

Group-Building Costs Cut by Gantry Concreting Plant

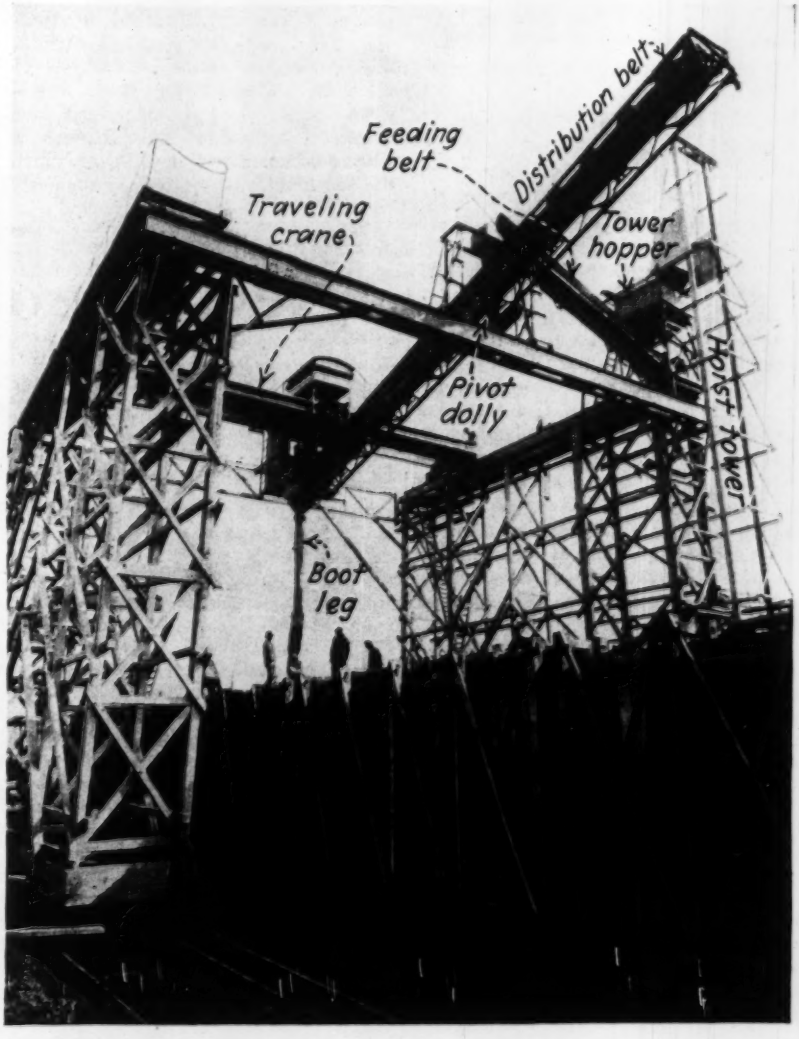
TIME AND COST were reduced by the gantry concreting plant illustrated in constructing dwelling colonies at Duessenberg and Zehlendorf, Germany. These structures consisted at Duessenberg of 500 dwellings and at Zehlendorf of 900 dwellings in fifteen and seventeen three-story blocks, respectively. The aggregate lengths of the blocks were 4,920 and 6,216 ft., respectively, and the times of construction were 24 and 28 weeks. The concrete was an earth-moist lean mix of cement and slag in the proportions of 1:10 and 1:13 for the lower and 1:15 for the upper stories. This concrete developed strengths of 850 to 1,000 lb. per sq.in. in 28 days.

The structures in both developments were long buildings of uniform design, and construction was wholly a repetition of operations carried out in two stages. The first stage was basement and ground-floor construction. The concreting was done by mixers running on tracks alongside the buildings and discharging into distributing belt conveyors. With the ground floor completed, forms for the first-story walls were erected, and the gantry concreting plant was put in operation as shown by the accompanying illustration.

The legs of the gantry were timber stagings on wheels. In one leg was located a concrete mixer and a hoist tower with a storage hopper at one side at the top. The mixer was charged from batch cars on an industrial railway leading to it from centrally located batching bins. The distributing elements, besides the hoist tower, are a feeding belt conveyor and a distributing belt conveyor with its boot-leg chute. The feeding conveyor is fixed, but the distributing conveyor can be traversed longitudinally and swung radially so as to cover, with the boot-leg, a considerable length of wall and area of floor.

In practice the first-story (12-in.) walls were concreted, then the second-story floor, then the second-story walls and third floor and so on to the roof. Lintel fittings and door and window inserts were fitted into the forms and concreted into the walls. In favorable weather the forms were struck in 24 hours and always within 48 hours. From 65 to 80 cu.yd. of concrete was placed in a day's work. The cost was estimated as about 10 per cent less than by ordinary methods.

Traveling gantry for concreting group-dwellings for German industrial colonies.



Bituminized-Cement Macadam Road Experiments

Test roads in this country and more than 200 miles of European roads resurfaced with stone penetrated with a mortar of bitumen-impregnated cement indicate new road type possibilities

PENETRATION MACADAM road surfacing made with a binder of portland cement-bitumen admixture has gained an important place in the last two years in the extensive road reconstruction program required in Europe following the lag of improvement during the World War and the ravages of war traffic. At present about 200 miles of this new resurfacing is in service in many stretches up to 1½ or 2 miles in length in Germany, France, Switzerland, Jugoslavia and Finland. In general this resurfacing has been on well-established waterbound and bituminous macadam, the surface of which had been impaired and was rapidly going to pieces under heavy modern traffic. The solid foundation of these roads required only, in most cases, a thin surfacing to be entirely stable under traffic.

Field observations

At this early stage of their use specific service records of these roads are not available. Observations of the roads in a number of localities by an American engineer and letters from European road officials, however, give the following information:

In Dresden, Germany, the oldest penetration pavements made with the new binder were constructed in 1931 and at the time examined were from ten months to a year old. The surfacing had been laid over old macadam, which was scarified and graded to profile and then surfaced in two courses, a base of 1- to 2½-in. crushed granite and a top course of ¾- to 1-in. stone and a seal of stone chips. The depth of rolled surfacing was from 2½ to 3 in. Most of the new surfaces were on residence streets, but one was located on Overbrook St., having an industrial traffic of 800 to 1,000 tons a day, of which a considerable part was on steel tires. These roads showed no cracks or disintegration, nor did roads of similar construction for rural service examined in a drive from Dresden to Munich and in Bavaria. The Bavarian roads had used 2-in. stone and 1:2 grout for the base and ¾- to 1-in. stone and 1:2 grout for the top course.

A statement from the road department of the Saxon Ministry of Finance gives the cost of surfacing of about 3½ in. as about 3¾ marks a square yard when using the bituminized cement and doing the work with its own forces. It is stated that the new roads can be opened to traffic immediately after rolling and that no cracks had formed in the surfacing. According to the experience so far gained, it is considered that a 1- to 1½-in. stone and a 1:1 grout would be an advantage with perhaps a surface dressing of neat grout for the top course.

Laboratory tests

Tests made at the road-materials testing laboratory of the Technische Hochschule, Stuttgart, early in 1932 gave the following results: A circular track, approximately 30 ft. in diameter and 24 in. in width, was laid in a trough in the concrete floor, on which a machine weighing 9¾ tons was rotated. The pavement was laid about 3¼ in. thick and rolled with the testing machine, which was fitted with iron wheels 15 in. wide. After rolling, these wheels were removed and pneumatic-tired wheels substituted; this change of wheels occupied two days, after which the machine was rotated continuously for five days at a speed of 10½ miles per hour for a total of 143,700 tons. Abrasion was measured at three equidistant points, and an average wear of 0.1 mm. was noted. Then the pneumatic tires were removed and solid tires substituted for a total of 141,100 tons. Then these solid tires were removed, the iron wheels previously mentioned were attached, and the machine was rotated at a speed of 2½ miles per hour for a total of 106,500 tons, during which a wear of approximately 11 mm. was noted. These wheels were then removed and solid tires were used at a speed of 14 miles per hour for a total of 91,800 tons, and a wear of approximately 0.3 mm. was noted. This pavement was subjected to a total of 502,800 tons of traffic with a total of 11½ mm. of wear. The surface had the appearance of mosaic and was very smooth with no signs of disintegration.

Other studies

In America experimentation has been begun. Late last year the Medusa Portland Cement Co. constructed a half-mile road at the York, Pa., plant, and this year another half-mile road at the Toledo, Ohio, plant, from bituminized cement produced at its own mills. These roads have a heavy yard traffic of cement trucks, one has passed through a winter, and neither has developed cracks or shown disintegration. The construction of other test roads has been arranged for with state highway departments, using the new cement.

A New Type of Cement Road in Use in Europe

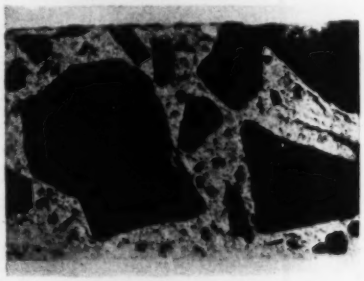
Experience with stone roads penetrated with bituminized-cement grout warrants attention by highway engineers

By Otto Graf
Professor, Technische Hochschule, Stuttgart, Germany

THE PRESENT economic conditions call for moderate-priced types of construction in the whole building world, and roadbuilding is no exception. For this reason, owing to the high cost of concrete roads, attempts are being made at present to replace them by other methods of construction. Along this line of thought the cement-bound macadam road (which in the United States is known as Hassam pavement) has lately received special consideration. The principle of this type of road consists in rolling together coarse-stone aggregate and cement mortar in such a way that the voids are filled with cement mortar. While the process is similar to that of constructing macadam road, the structure approaches that of a concrete road. Fig. 1 shows a section from such a road.

When making cement macadam roads

Fig. 1 — Section cut from bituminized-cement penetration-macadam pavement showing complete penetration of voids.



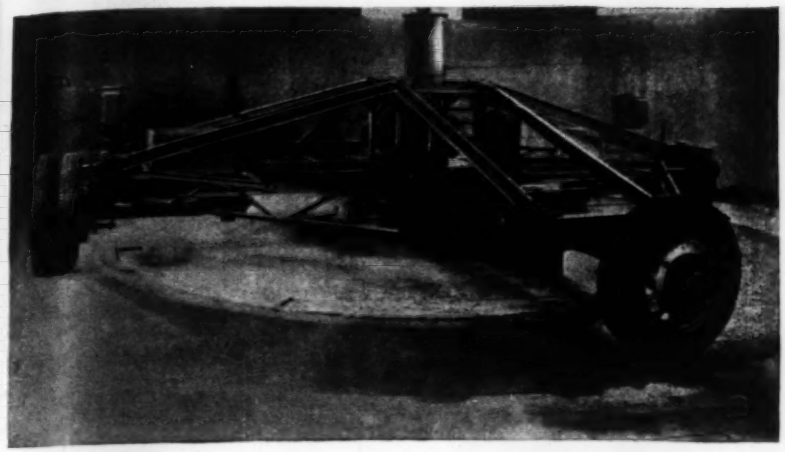


Fig. 2—Machine at Technische Hochschule, Stuttgart, road-materials laboratory, used in testing bituminized-cement road.

it is desirable to use cement which does not set—even in summer weather—until the rolling is completed, even though the latter requires several hours, as for instance in the case of building in several layers. Moreover, the concrete so produced should show less change of volume under the influence of weather (sun, wind, rain, high and low temperatures) than the ordinary concrete road, since the cement macadam roads, for economical reasons, should if at all possible be constructed without joints, as it is not possible to get satisfactory compression by the roller near the joints.

The problem of manufacturing a cement with delayed initial hardening and with delayed swelling and shrinkage has recently been taken up in Germany in a special manner. In the course of the experiments so far carried out a novel method of blending cement and bitumen has been developed. The result has been to delay the hardening process to the necessary degree. Observations so far made, moreover, seem to indicate that when using this binder the swelling and shrinking process is retarded to such a degree that under changing weather conditions the extremes are reduced in a remarkable degree.

According to reports I have received, a stretch of road about 1 mile long which was rolled, without joints, about three months ago (summer of 1932) is so far absolutely without cracks, while an adjacent stretch constructed in a similar manner with ordinary portland cement already shows many cross and also longitudinal cracks. Similar reports have been received on another road which was constructed in 1931 and which has already gone through the winter.

Extensive laboratory experiments clearly prove that the admixture of bitumen results in a marked mitigation of the internal tensions during alternate wet and dry storage and alternate high and low temperatures, thereby diminishing the danger of formation of cracks.

The technique of admixing bitumen to cement has recently been so far developed that cements can now be mixed with bitumen in very fine distribution. It has already been established that the reduction of strength caused by the bitumen remains within modest limits. This also is a problem to be studied in detail, with a special view to determining the practical limits.

In order to ascertain the durability of a road made with the new binder an experimental stretch was constructed into the apparatus shown in Fig. 2. The road was put under test three days after completion, and heavy loads, both with iron wheels and pneumatic tires, were run over it at varying speeds.

After 502,800 tons had gone over the road, it was broken up and tested for compression and bending strengths. The mean bending strength of test specimens which broke in the center with 10 in. distance of support under a single load was 540 lb. per sq.in. The compressive strength was between 2850 and 4480 lb. per sq.in. These strengths are satisfactory.

All that has so far been established regarding this new binder makes it evident that its use should be followed with the greatest attention, as the properties sought will be of importance in other fields than roadbuilding.

New Ocean Port for China Proposed by Commission

AN ICE-FREE deep-water ocean port, as now proposed, on the Gulf of Po Hai, a branch of the Yellow Sea, is the revival of a project long needed to serve the interests of North China. In 1919 the province of Chihli proposed to carry out the project. Nothing was done, however, and in 1929 the national government constituted a special board to investigate the conditions. In 1931 this board was reorganized, with Dr. Shu-tien Li as chairman and chief engineer, and its report was issued in December, 1931.

In location the proposed port, 96 miles northeast of Tientsin, is near large salt-producing and agricultural districts and is only about 40 miles from the Kailan coal mine. Although Tientsin, on the Hai River, is a commercial center of North China, its port is shallow and is frozen in the winter, while attempts to deepen it and prevent the continual silting have not been successful. The new deep-water port, open all the year, would be conveniently located for ocean-liner services. Its location is 126 miles south of the other proposed port of Hulutao, which project has been interrupted by the recent Japanese military occupation of Manchuria. The tidal range is about 8 ft. Although ice occurs occasionally, it is usually so thin as to be broken up or blown away from the shore by prevailing winds. The port of Chingwangtao, in the same gulf, is free from ice but is a small place and less advantageous than the proposed port. The Lan River, which discharges into the gulf in the vicinity of the site, may be improved for inland navigation by barges and shallow-draft steamers, while a 52-mile railway to Tangshan would connect with the Peiping-Liaoning Railway and thence with other existing main lines.

Works proposed for the first five-year construction period, estimated to cost $23,000,000, include a basin and entrance channel; a pier and quay, each 400 ft. wide with 6,000 ft. total waterfront built for handling construction a pile pier for handling construction material, transit sheds, waterworks, and an electric light and power plant. A second period would include drydocks, additional port and railroad facilities, a breakwater and various city improvements, all estimated at $19,000,000. A third period provides for further developments estimated at $20,000,000, making a total cost of $62,000,000.

For financing it is suggested that the national government should issue 26-year port bonds for 66 per cent of the total cost, or $40,000,000 to be expended during ten years, the remainder to be provided from customs revenue and sale of land. Foreign loans are also suggested. No action has been taken as yet on the project by the Chinese government.

Illinois Waterway Will Be Ready for 1933 Season

THE NAVIGATION features of the Illinois Waterway from Lockport to Starved Rock, the final incompleted link in the Lakes-to-the-Gulf Waterway, are in the final stage of construction, according to Lieut.-Col. Dan I. Sultan, U. S. district engineer in charge. More than 1,000 men are engaged in the field or in fabricating plants completing the structures and dredging the channel. A minimum 9-ft. depth and 200-ft. width is being provided. The present controlling bridge clearances of 27 ft. vertical is at the Illinois Central bridge at La Salle. The bridge is to be completed by May, 1933, and thereafter there will be a clearance of 44 ft. from the Mississippi to Starved Rock. The width will then be 118 ft. minimum.

River navigation on the Mississippi above Cairo, because of ice conditions, is not carried on during the winter months, that city being the northern terminus of the winter operations of the Federal Barge Line. Under ordinary winter conditions, navigation on the Illinois River is suspended during the months of December, January and February because of ice conditions. The War Department was familiar with those facts, but it was desired to complete the navigation features so as to provide a usable channel by about Oct. 15, 1932, in order to be ready for traffic in the spring and to enable operators of towboats to make definite plans for their spring operations. So far as the navigation features are concerned, this goal will be reached.

The lock and dam at Starved Rock is now in operation. Navigation through the Starved Rock pool, past Ottawa, and to the lock and dam at Marseilles is now possible. The controlling depth in that pool on Oct. 15 will be 9 ft., and the contract for widening the channel calls for completion in December. On Oct. 15 the controlling bridge clearances in this pool will be 19 ft. vertical and 170 ft. horizontal. The Secretary of War has ordered that all bridges in the pool shall be reconstructed by March 1, 1933, to provide a minimum vertical clearance of 47 ft. above normal pool stage and a minimum horizontal clearance of 110 ft.

The lock at Marseilles is complete. Work on the dam has been delayed by labor difficulties, but the contractor is now making excellent progress, and the structure will be in usable condition by Oct. 15. A channel through the pool past Seneca and Morris to the lock and dam at Dresden Island will be available in October. Widening to full project width will be completed next spring. In this pool the controlling clearances at bridges on Oct. 15 will be 133 ft. horizontal and 17 ft. vertical. The Secretary of War has ordered that all bridges in the pool shall be reconstructed by March 1, 1933, so as to provide a minimum vertical clearance of 47 ft. above normal pool stage and a minimum horizontal clearance of 110 ft.

The lock and dam at Dresden Island will be completed and in operation by Oct. 15. Dredging in the pool to carry the channel to the lock and dam at Brandon Road, just below Joliet, is being pushed vigorously. A channel at least 100 ft. in width will be available by Oct. 15. The contract for this dredging calls for completion of the channel to full project width in December. The contractor for the state is building the new Smith's highway bridge with all possible speed, but completion cannot be expected before midwinter. The old bridge will block navigation above the site until removed.

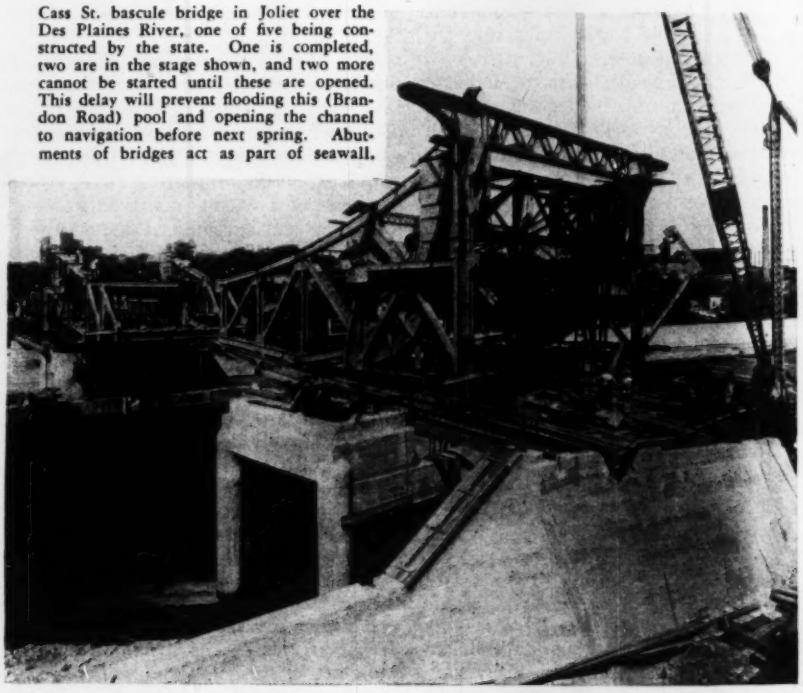
The Brandon Road lock and dam has been completed and will be ready for operation by Oct. 15. The dam cannot be closed and the pool created until the abutments for the new bridges in Joliet have been constructed by the state, since these abutments will close the gaps in the retaining walls, which are being built to prevent the flooding of the city by water from the pool. The other sections of the walls will be completed by the federal government by Oct. 15.

The bridge situation in Joliet is an exceedingly complicated one. The Rock Island R.R. bridge has been completed except for operating machinery and the fender system, both of which are to be provided by next March. The New Jackson St. bridge is open to traffic. The old bridges at Cass and Jefferson Sts. have been removed, and work on the new bridges is being pushed vigorously by the state. Joliet, in order to protect itself against serious inconvenience and fire hazards, sought and was granted an injunction which prevented the state from removing the McDonough St. bridge and the temporary bridge at Van Buren St. until the Jefferson St. bridge is in use this winter.

At the present time, it appears that the state will be unable to complete its portion of the work in Joliet, which is necessary to permit the opening of navigation through the Brandon Road pool prior to early spring, but the state and the United States are cooperating in every way possible to complete this work at the earliest practicable date.

With the exception of the bridges, the Jackson St. dam is the only obstacle to navigation through the Joliet pool. The advertisement for bids for the removal of the dam has been withdrawn following the granting of the injunction referred to above. Removing the dam is a simple matter, but it cannot be done until the pool is created, as damage would result to the Sanitary District power plant at Lockport. Upon the removal of the dam there will be available a channel with minimum depth of 10 ft. and minimum width of 150 ft. throughout the pool. Plans for widening the channel are being prepared, but this work is a betterment and is not essential to the opening of navigation.

Dredging is in progress just above the lock at Lockport and by Oct. 15 the lock will be in operation, and navigation will be possible via the Chicago Sanitary District Canal to Chicago and Lake Michigan.



Cass St. bascule bridge in Joliet over the Des Plaines River, one of five being constructed by the state. One is completed, two are in the stage shown, and two more cannot be started until these are opened. This delay will prevent flooding this (Brandon Road) pool and opening the channel to navigation before next spring. Abutments of bridges act as part of seawall.

Modern Power-Unit Practice in Gas-Electric Excavators

By David Stoetzel
Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

IN ANY FORM of electric drive for shovels it is desirable to introduce generating equipment on the machine itself to supply direct current to individual motors actuating the various motions. In the straight electric machine operating from an alternating-current power supply, the motor driving the generator will be either the squirrel-cage induction or the synchronous type. On the gas-electric machine the induction motor is replaced by the gas or oil engine. The characteristics of the driven generator will be approximately the same whether the driving element is the electric motor or the engine. The controllers, direct-current motors and other parts of the equipment will also be the same.

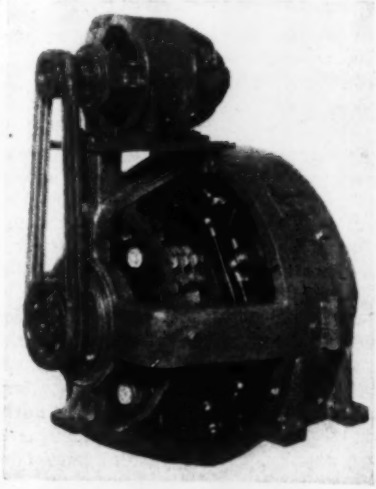
The physical make-up of the generating equipment may be considerably different on the engine-driven machine on account of the lower speed, usually about 1,800 r.p.m. For one thing, the engine-driven generating equipment will be larger for the same electrical characteristics.

Some of the minor accessories, as for example the exciter and the air compressor, will be different on the engine-driven outfit. The exciter will usually be belt-driven, and the air compressor, if used at all, will be incorporated as part of the engine. A refinement in the engine-driven machine, consisting of complete starting and lighting equipment somewhat similar to that used on automobiles, is meeting with favor.

The gas-electric shovel or dragline is necessarily somewhat more complicated than the straight electric machine, and the maintenance expense on the engine is an appreciable factor. While the gas-electric shovel will run up higher charges, part of which are offset against the charges for electric power on the straight electric machine, it possesses certain important characteristics which, in some measure, justify its present popularity, particularly in the smaller sizes. The primary advantage is its comparatively greater mobility. Also it is possible to operate it at points remote from power lines.

On any excavating machine the electrical equipment must be compact and sturdy. This is particularly true of the gas-electric, since the engine is a comparatively large unit and occupies space that would otherwise be available for the electrical parts. The generator must be coupled directly to the engine, and the power plant must be mounted crosswise of the cab and at the rear of the shovel. For small and medium-size machines, the over-all length of the combination must not exceed 120 in., which is the maximum shipping clearance.

Generator and exciter for diesel-electric power shovel.



Walking dragline excavator equipped with diesel-electric power unit.

For small machines that are used more or less intermittently it is necessary to keep the capital investment low. Since the gas-powered machine is most frequently used under such conditions, the price of the electrical parts must be kept as low as possible, consistent with satisfactory operation; and in some cases it is necessary to sacrifice minor operating advantages when the price is decreased appreciably by such omissions.

Probably the chief advantage of the gas-electric machine is its independence of any power supply. Transmission lines, transformers, trailing cable, switches and protective devices are eliminated. There are no questions regarding interruptions in electric service. Voltage, frequency, power factor, demand charge and related matters may be forgotten. The machine can go anywhere providing the ground will support its weight; the grades are not in excess of what the machine is geared for; and the transportation facilities will permit bringing up regularly the gas and oil supplies required.

Usually the straight electric machine has greater capacity for handling peak loads. The squirrel-cage induction motor or the synchronous-induction motor on such a machine has a maximum running torque 100 to 150 per cent above its rated full-load torque, while the gasoline or diesel engine has little or no torque in excess of its normal full-load rating. Since the shovel load is a succession of very sharp peaks, and the equivalent continuous load is only a minor fraction of the peak load, it is apparent that the gas-powered machine must be considerably over-motored as regards average power required; and it will be necessary to adjust the characteristics of the electrical equipment so that the maximum possible peaks will not be in excess of the maximum power of the engine.

For medium-size shovels Ward Leonard has been found to be superior to rheostatic-type control. This involves individual generators for the several motors and results in a comparatively long motor-generator set. As the internal combustion engine takes up considerable space, particularly in a direction parallel to the shaft, it is extremely difficult to design a set consisting of the engine and a series of generators sufficiently short to be accommodated on the shovel. For this reason the gas-electric excavator nearly always employs rheostatic-type control, which, while slightly inferior to the Ward Leonard in performance, is cheaper in first cost and more economical of space. Recently considerable progress has been made with designs for Ward Leonard equipment to be driven by gas or diesel engines. These are along the lines of locating some of the smaller generators on top of the largest machine, using V-belt or a similar drive between the engine or main-generator shaft and the shaft line of these stacked-up machines.

The Heat Evolved by Cement During Hardening

Tests of cements determine the influence of composition on the heat evolved during hardening

By Hubert Woods, Harold H. Steinour and Howard R. Starke
Riverside Cement Co., Riverside, Calif.

THIS ARTICLE summarizes one of a series of studies conducted by the research department of the Riverside Cement Co., of California, into the properties of portland cement. The properties investigated have been (1) heat evolution during hardening, (2) strength of mortars, and (3) volume change of mortars. The article that follows covers the study on heat evolution, and the study of mortar strengths will be summarized in an article to be published soon. The studies have been carried out by Hubert Woods, Harold H. Steinour and Howard R. Starke for the research laboratory. The summary given here is condensed from a detailed report describing methods and apparatus and giving at length the methods of analysis and computation. —EDITOR.

THE INVESTIGATION described here deals with the heat of hardening defined as the total quantity of heat evolved by portland cement from the time of the addition of gaging water until the end of the periods for which it is given. This property is of interest in the construction of massive works, such as dams, in which the great thicknesses severely hinder the outflow of the heat. The consequent rise in temperature while the cement is hardening may result in contractions and cracking when the eventual cooling to the surrounding temperature takes place.

In order to eliminate so far as possible the disturbing influence of several otherwise uncontrollable factors, this investigation was carried out with carefully prepared cements produced in the laboratory.

The cement compositions were varied over a wide range with a view to bringing out the essential factors governing heat evolution. The heat evolutions were determined over various intervals of time up to 180 days, using for this purpose samples of neat cement made up to a water content of 40 per cent of the weight of cement and stored at 95 deg. F.

Experimental methods

The amounts of heat evolved by the hardening cement pastes, from the time of mixing up to the time of test, were determined indirectly from the heats of solution of the various samples in an acid solvent.[1] The principle upon which this determination is based is Hess's law of constant heat summation[2] —namely, the change in heat content of a system in passing from one state to another is independent of the path whereby the passage is made. As applied to the present work, this method requires a determination of (1) the heat of solution of the cement in its initial state (that is, unreacted), (2) the heats of solution of the cement after reaction with water for various lengths of time, and (3) the difference between the two quantities to obtain the value of the heat evolved on hardening.

Finenesses were determined on a 200-mesh sieve. However, previous work done here has shown that equality of fineness as measured by a given sieve is no proper criterion of equality of effective fineness for cements of varied composition and physical characteristics, even when the same mill and grinding media are used throughout. A better measure of effective fineness is the "specific surface"—that is, the total surface of all the particles in unit weight of cement. The specific surfaces of all the cements produced in this investigation were determined by means of a sedimentation device developed at this laboratory.[3]

Because of the laboratory method of preparation all of these cements gave less residue on the 200-mesh screen than is generally the case with commercial cements of the same specific surfaces. The surface values correspond to good commercial practice.

Valid criticism may be directed at the time-temperature history chosen for curing the hardening cements, on the ground that actual massive concrete structures do not remain at constant temperature but vary, first upward, fairly rapidly, and later downward, usually less rapidly. However, the same type of criticism could be directed at any arbitrary time-temperature history that might be chosen. The actual time-temperature history of a concrete structure depends on a large number of factors other than the nature of the cement. The mix proportions, the water-cement ratio, the specific heat of the aggregate, the size and shape of the structure, the manner and rate of construction, all have a decided influence on the actual time-temperature history. Hence any arbitrarily chosen curing temperature or temperature history could be objected to as applying strictly only to a small proportion of the structures in connection with which heat data might be of interest.

While the temperature history undoubtedly influences in some degree the heat evolution, there is reason to believe that the conclusions here reached are generally valid.

Experimental data

The chemical composition of each clinker prepared for this investigation is given in Table I, together with the temperature at which the firing took place. The clinker compounds were calculated in accordance with the findings of Bogue and his staff.[4] A study of the figures in the table shows the following wide ranges in calculated compound composition:

	Per Cent
Tetracalcium alumino-ferrite, ($4CaO.Al_2O_3.Fe_2O_3$)	3.6–22.7
Tricalcium aluminate, ($3CaO.Al_2O_3$)	0.6–21.3
Beta-dicalcium silicate, ($2CaO.SiO_2$)	6.2–61.1
Tricalcium silicate, ($3CaO.SiO_2$)	16.7–71.3

The quantities of heat liberated during the setting and hardening of the cements prepared from these clinkers are reported in Table II, together with data on amount of retarder, screen fineness, specific surface and initial heat of solution. Heat data are reported for ages up to six months.

Analyses of the data

Examination of Table II shows that the most rapid evolution of heat occurs during the first three days, and that after 28 days the rise is very gradual, although it continues throughout the six-month period and in some cases produces quite a fair increase. At the later ages the values for the various cements remain in approximately the same order that they have at three days.

As regards the contributions made by

TABLE I — CLINKER COMPOSITION OF CEMENTS TESTED FOR EVOLUTION OF HEAT

Cement No.	Clinker Temp. During Burning, Centigrade	Clinker Analysis, Per Cent: SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO: Total	CaO: Uncombined	Clinker Compounds Calculated, Per Cent: $4CaO.Al_2O_3.Fe_2O_3$	$3CaO.Al_2O_3$	$2CaO.SiO_2$	$3CaO.SiO_2$
2122	1400	27.68	3.76	1.98	2.48	64.97	0.00	6.0	6.6	59.7	26.0
2123	1400	25.96	3.48	5.06	2.32	63.15	0.00	15.4	0.7	52.4	29.2
2092	1440	21.86	5.75	2.77	5.04	65.02	0.00	8.4	10.6	20.4	56.0
2088	1400	24.60	5.85	2.80	2.40	64.18	0.00	8.5	10.8	47.1	31.0
2096	1450	25.04	3.86	2.11	2.36	66.57	0.00	6.4	6.7	32.7	51.8
2085	1400	22.32	6.17	2.85	2.43	66.47	0.00	8.7	11.5	22.2	55.5
2086	1400	22.32	6.17	2.85	2.43	66.47	0.00	8.7	11.5	22.2	55.5
2087	1400	22.32	6.17	2.85	2.43	66.47	0.00	8.7	11.5	22.2	55.5
2094	1500	20.93	4.64	5.74	2.08	66.26	0.00	17.5	2.6	6.2	71.3
2124	1400	23.54	4.83	7.21	2.24	62.03	0.00	21.9	0.6	44.2	30.9
2089	1400	21.96	4.65	6.06	2.32	64.07	0.00	18.4	2.1	22.2	54.0
2090	1400	21.44	8.81	1.19	2.48	66.64	0.00	3.6	21.3	25.7	47.5
2093	1400	21.44	8.81	1.19	2.48	66.64	0.00	3.6	21.3	25.7	47.5
2125	1400	22.48	5.00	7.46	2.24	62.72	0.00	22.7	0.6	34.1	40.2
2095	1400	21.34	6.07	2.93	2.56	67.03	0.03	8.9	11.1	11.6	65.7
2091	1500	21.94	5.57	2.68	2.44	67.71	0.00	8.2	10.2	11.8	67.7
2170	1400	25.72	4.12	6.06	2.08	61.05	0.00	18.4	0.7	61.1	16.7

TABLE II — HEAT VALUES AND OTHER DATA ON CEMENT OF COMPOSITIONS SHOWN IN TABLE I

Cement No.	Gypsum Per Cent	SO_3 Calculated, Per Cent	Fineness by 200M Screen, Per Cent Passing	Specific Surface, Sq.Cm. per Gm.	Initial Heat of Solution Cal/Gm.	Heat of Hardening at 35°C. (95°F.) Neat Cement with 40 Per Cent of Water Cal. per gm. at 3 Days	7 Days	28 Days	90 Days	180 Days
2122	3.23	1.5	99.9	1,390	588.7	51.2	53.1	72.5	81.2	78.5
2123	3.23	1.5	99.5	1,450	575.7	40.6	45.7	61.0	71.9	74.3
2092	3.23	1.5	99.9	1,470	623.6	74.8	84.7	92.2	100.6	104.3
2088	3.23	1.5	99.8	1,480	595.5	53.2	63.1	73.7	77.7	87.6
2096	3.23	1.5	99.9	1,500	604.5	71.9	78.8	88.8	92.6	95.9
2085	3.23	1.5	99.9	1,530	618.8	77.5*	90.3	101.0	103.7	109.2
2086	4.31	2.0	....	....	611.6	73.3	91.5	97.7	103.3	108.0
2087	3.23†	1.5	....	....	623.0	79.1	91.5	96.3	104 1	110.2
2094	3.23	1.5	99.9	1,560	610.0	77.3	87.5	92.4	100.5	102.7
2124	3.23	1.5	99.8	1,570	573.0	42.1	46.8	61.5	70.0	72.5
2089	3.23	1.5	99.9	1,580	599.0	64.7	77.9	85.8	90.1	93.1
2090	3.23	1.5	99.9	1,540	633.4	89.5	96.6	108.8	114.1	115.9
2093	6.46	3.0	....	1,600	611.1	90.6	95.2	106.4	108.7	114.0
2125	3.23	1.5	99.9	1,620	585.9	58.8	62.8	74.2	78.1	83.8
2095	3.23	1.5	99.9	1,630	625.6	84.8	94.5	103.7	107.5	113.3
2091	3.23	1.5	99.9	1,670	624.0	84.0	91.3	99.9	106.2	109.4
2170	3.23	1.5	99.7	1,530	564.7	28.3	36.3	49.8	.....	.....

* Average value, two tests.
† Added as gypsum and converted to plaster of Paris by heating at a maximum temperature of 150° C. after milling (determined by loss of weight).

the individual constituents to the total heat evolution of a cement, consideration will first be given to those pairs of cements in which but one item was intentionally varied. As there was but a single pair for each, the results must be regarded more as indications than as having real quantitative significance.

The only variation of this nature that was made in clinker was that with respect to magnesia. Nos. 2085 and 2092 are the compositions concerned. Their analyses are sufficiently close that in respects other than magnesia not more than a calorie or two of difference in the heats would be expected on the basis of the mathematical analysis that follows. Nevertheless, No. 2092, which contains roughly 2.5 per cent more MgO, exhibits at all ages the lower heat of hardening, and the difference are 2.7, 5.6, 8.8, 3.1 and 4.9 calories, or 1.1, 2.2, 3.5, 1.2 and 2.0 calories per cent of MgO.

Variation in the amount or nature of the retarder was made in cements numbered 2085, 2086, 2087, 2090 and 2093. Comparison of No. 2085 with No. 2086, and No. 2090 with No. 2093 shows no significant difference, indicating that the additional gypsum in Nos. 2086 and 2093 was without appreciable effect. Likewise, the plaster of Paris in No. 2087 has not caused it to have heats of hardening significantly different from those of No. 2085.

Proceeding now to the analysis of the group, there are fourteen clinkers represented by the cements of Table II. Omitting those cements, Nos. 2086, 2087 and 2093, which were prepared from the same clinkers as others of the series but with variations in the amount or nature of the retarder, there remain fourteen cements, one for each clinker. Of these, No. 2170 was prepared so late that the 90-day data are yet lacking. Consequently, it is desirable to disregard it also for the time being, leaving thirteen cements, corresponding to thirteen widely different clinkers, and for which the heats of hardening for 3, 7, 28, 90 and 180 days have been determined.

These thirteen cements and the heats of hardening that were found for them have been subjected to mathematical analysis by the method of least squares to obtain the contribution made by each per cent of each of the major compounds to the total heat of hardening, together with the corresponding probable errors. Probable error as here used is defined as an error of such a magnitude that the probability of making an error greater than it in any given observation is equal to the probability of making one less than it. The method conformed throughout to standard practice in the adjustment of unconditioned indirect observations of equal weight. (The heat evolutions determined for each cement were considered to be of equal weight.)

The results of this analysis are shown in Table III. The differences between the heats of hardening calculated for each cement at each age by means of these values applied to the data of Table I (after conversion of the latter to a cement basis) and the heats of hardening obtained experimentally are given in Table IV, together with the probable error calculated for each age. In the latter table the results have been applied to No. 2170 also, which, because its data are incomplete, had not been included in the analysis. The specific surfaces of the cements are recorded again in this table for comparison.

Fig. 1 shows graphically the data of Table III. It will be noted that the probable errors vary considerably from one compound to another, which is consistent with the different percentages at which the compounds are present in the different cements and with the extent of their variation. There is also noticeable variation in the probable errors at the different ages, which is to be expected because of the very limited number of compositions upon which the analysis was made.

As regards the magnitudes of the probable errors in the total heats of hardening, as shown in Table IV, in no case is the value greater than two times the 1.5 calories that might be expected as calorimeter error alone. As there are undoubtedly errors in the analysis sufficient to alter appreciably the actual percentages of the compounds, the agreement obtained is considered to be fully as good as could be expected.

Examination of Table III or Fig. 1 shows that the compounds, ranked in

TABLE III — CONTRIBUTION OF THE INDIVIDUAL COMPOUNDS TO THE HEAT OF HARDENING

Contribution of each per cent in cement to the heat evolution per gram of cement

Compound	Calories at: 3 Days Value	3 Days Probable Error	7 Days Value	7 Days Probable Error	28 Days Value	28 Days Probable Error	90 Days Value	90 Days Probable Error	180 Days Value	180 Days Probable Error
$3CaO.Al_2O_3$	1.70	±0.20	1.88	±0.19	2.02	±0.20	1.88	±0.18	2.18	±0.11
$3CaO.SiO_2$	0.983	±0.054	1.100	±0.049	1.142	±0.054	1.224	±0.049	1.206	±0.029
$4CaO.Al_2O_3$ Fe_2O_3....	0.29	±0.18	0.43	±0.16	0.48	±0.18	0.47	±0.16	0.73	±0.10
$2CaO.SiO_2$...	0.195	±0.046	0.181	±0.041	0.436	±0.045	0.552	±0.041	0.526	±0.024

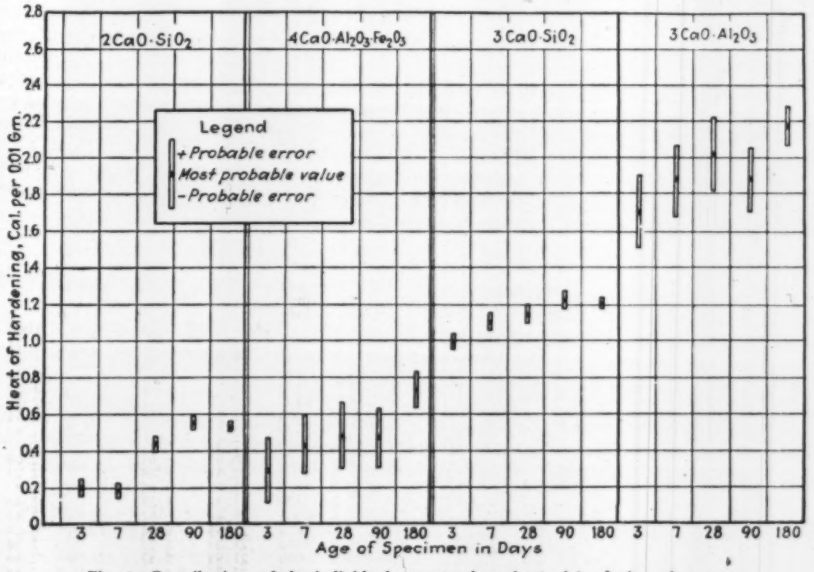


Fig. 1—Contributions of the individual compounds to heat of hardening of cement.

descending order on the basis of the magnitude of the heat evolution during the first three days, are:

Tricalcium aluminate, ($3CaO.Al_2O_3$)
Tricalcium silicate, ($3CaO.SiO_2$)
Tetracalcium-alumino-ferrite, ($4CaO.Al_2O_3.Fe_2O_3$)
Beta-dicalcium silicate, ($2CaO.SiO_2$)

Thereafter there is an increase in the value for each compound, but the same order is in general maintained. The values for the ferrite and dicalcium silicate keep close together, however, at the bottom of the scale, with one reversal of order shown by the analysis. The predominance of the values for the tricalcium compounds and the close agreement of those for the other two compounds make a function of the tricalcium compounds alone a fairly good measure of the heat evolution. This is shown in Fig. 2 in which the 3-day and 180-day heats are plotted against per cent of $3CaO.SiO_2 + 2.1$ times the per cent of $3CaO.Al_2O_3$).

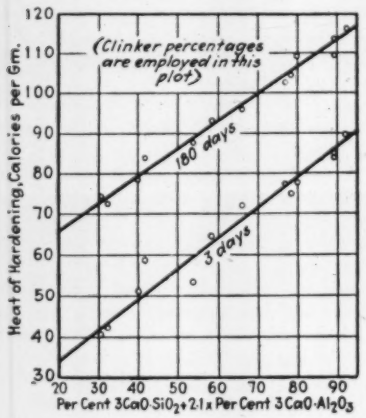


Fig. 2—Correlation between heat of hardening and a function of the tricalcium compounds; plot is based on clinker percentages.

This simple function is a useful one for quick rough approximation of the relative standing of two cements (differing only in composition) in point of heat evolution. However, since cement compositions are generally reported only in terms of the oxide composition, the necessity of calculating the compounds further complicates the matter. This renders desirable the interpretation of the heat data in terms of oxide composition. Such an alternate treatment is also desirable from certain viewpoints simply because it does avoid the theory of the mineralogical constitution of clinker. Since the percentage of each compound is a linear function of the percentages of the oxides[5], the desired transformation may readily be made. The results are shown in Table V.

In applying these data to cements the per cent of CaO must be corrected for CaO present in the retarder as $CaSO_4$. The amount to be subtracted is 0.7 times the amount of SO_3, which is reported in the analysis. Any uncombined or free lime should also be subtracted if it can be determined. The effect of free lime on the heat evolution has not been determined experimentally, but to the extent to which it has hydrated or carbonated prior to the use of the cement it probably has no very direct effect.

Its presence, however, indicates that there is more dicalcium silicate and less tricalcium silicate than would otherwise be the case, and this situation is taken care of by subtracting the free lime from the total lime.

There are several practical aspects from which the reliability of the mathematical analysis presented in this paper may be viewed: the magnitudes of the probable errors, the time sequence of the constants obtained for each compound, and the values of those constants themselves. The reasonableness of the probable errors found for the direct determinations has already received comment. The probable errors calculated for the compounds are in all cases less than the values of the constants that were obtained; and in the case of the tricalcium compounds, which evolve the most heat, the values are several times as large as the calculated errors. Although in some cases the trends of the values with increased age of specimen show fluctuation, they all proceed upward, and in general the irregularities are no greater than might be expected from the magnitudes of the probable errors. There exists, most fortunately, a very satisfactory means for estimating the reliability of the high values obtained for tricalcium aluminate. Thorvaldson, Brown and Peaker[6] have determined the heat of hydration of the pure compound.

All things considered, the values calculated for the later ages in the present study are in excellent agreement with their value of 214 calories per gram at 20 deg. C. for conversion to the stable hexa-hydrate. Even their value of 261 calories per gram for conversion to the most highly hydrated form ($11.6\ H_2O$), for which they obtained data, is not excessively greater. As regards tricalcium silicate, which is believed to hydrolyze with attendant hydration of the liberated lime, the known heat evolution of this latter reaction is capable of accounting for a large proportion of that indicated for the silicate by the mathematical analysis. In fact, the heat of hydration of the lime that would have to be removed from the tricalcium silicate to convert it to dicalcium silicate amounts to 0.68 calories per 0.01 gram of the original silicate and thus corresponds roughly to the difference in the values obtained for these two compounds.

TABLE IV — DIFFERENCE BETWEEN THE EXPERIMENTAL HEAT VALUES OF THE CEMENTS AND THE VALUES CALCULATED FROM THE MOST PROBABLE VALUES FOR THE CEMENT COMPOUNDS

		Age of Cement Paste, Days				
		3	7	28	90	180
Probable Error, Cal.:		±2.56	±2.33	±2.54	±2.31	±1.36
Cement No.	Sp. Surface cm2/g					
2122	1,390	−2.7	−0.5	−2.9	−3.8	+0.4
2123	1,450	+2.6	+2.2	+1.9	−1.1	−1.2
2092	1,470	+2.1	+1.2	+2.9	−0.3	−0.3
2088	1,480	+5.3	+1.3	+5.5	+7.7	+1.3
2096	1,500	−3.6	−3.1	−1.7	+1.3	−0.2
2085	1,530	+0.8	−2.8	−3.8	−1.3	−2.7
2094	1,560	+0.9	+1.5	+2.2	−0.1	+1.5
2124	1,570	+2.8	+4.0	+2.6	+1.2	+2.8
2089	1,580	−0.5	−5.0	−4.1	−2.2	−1.3
2090	1,600	−3.5	−1.4	−2.2	−3.7	−0.0
2125	1,620	−6.7	−3.5	−3.6	−0.9	−2.2
2095	1,630	+0.7	+1.3	−0.4	+0.7	−1.0
2091	1,670	+1.7	+4.8	+3.7	+2.6	+2.9
2170	1,530	+5.5	+1.0	+4.3	....	....

Application of results

In applying the results of this analysis to commercial cements it is not to be expected that the agreement between calculated and experimental values will be as good as that shown in Table IV.

TABLE V — HEAT OF HARDENING IN TERMS OF OXIDE COMPOSITION
(Calculated from the data of Table III)

Oxide:	Contribution of each per cent in cement to the heat evolution of 1 gram of cement. Calories at:				
	3 days	7 days	28 days	90 days	180 days
CaO	+3.40	+3.92	+3.31	+3.28	+3.29
SiO_2	−5.79	−6.80	−4.93	−4.55	−4.65
Fe_2O_3	−3.2	−3.2	−3.1	−2.9	−2.6
Al_2O_3	−1.1	−1.5	−0.1	−0.4	+0.4

TABLE VI — COMMERCIAL CEMENTS DIFFERENCES BETWEEN THE EXPERIMENTAL HEAT VALUES AND THOSE CALCULATED FROM THE DATA OF TABLE V

Age of Paste, Days	Calculated Heat of Hardening Minus the Experimental Value, Cal. per Gm.			
	Brand 1	Brand 2	Brand 3	Brand 4
3	+10.9	+2.2	+4.2	+7.2
7	+10.8	+4.0	+3.3	+11.1
28	+11.5	+1.7	−0.1	+9.8
90	+10.7	+1.6	−0.6	+5.7
180	+4.5	+0.8	+0.3	+0.5

The commercial cements will vary in amount of free lime, which, due to partial carbonation, cannot be determined accurately. They will also differ in amount of minor constituents, whose influence, though believed to be small, is not definitely known. The specific surface of many of them will be outside the range in this experimental group, and their histories will be different. They will have been fired at different temperatures, cooled at different rates, stored for different periods under different conditions. Different small percentages of water will have been drawn from the atmosphere to produce surface hydration. These circumstances exert an influence on other properties of cement, and some influence on the rate of heat evolution is to be expected.

An indication of the magnitudes of such effects is afforded by the data of Table VI on four different brands of commercial cement of normal composition whose experimentally determined heats of hardening were 64.3 to 75.4 calories at three days and 93.2 to 102.3 calories at six months. It is of interest that the calculated values are nearly all larger than the experimental ones. However, with respect to brands 2 and 3 the agreement throughout is as good as might have been expected even had they been experimental cements. Brands 1 and 4, in which the discrepancies are larger, showed larger ignition losses than the other two cements. It is believed that surface hydration and other

effects of exposure may exert a strong influence in slowing up the rate of reaction, since it is known that undue exposure of cement may reduce its early strength markedly. Both of these brands (1 and 4) also tested higher in free lime than the others. This is perhaps significant because the method for determining it gives results which are low by the amount that has carbonated. These cements, being higher in free lime as determined (they had about 1 per cent), and also indicating greater exposure because of their higher ignition losses, probably have a greater amount of carbonated lime. Reference to Table V on the preceding page shows the large effect of each per cent of lime in the calculations.

No account was taken of the direct specific effect of free lime as such, but lime hydrates rapidly upon exposure, and in cements such as these, which were bought on the market, it is presumably largely hydrated already. The specific surfaces of the four cements exhibit no correlation with the magnitudes of the discrepancies, but all surface figures except that for brand 4 are a little lower than those of the group of experimental cements. At six months all of the calculated heats of hardening are in reasonable agreement with those obtained experimentally.

The conditions under which cement is utilized introduce further difficulties in the application of the results of a study such as this. There can be little doubt but that the heat evolution must vary considerably with the ratio of gaging water to cement and with the temperature history of the concrete, which latter is conditioned by the rate at which heat can escape.

These results, therefore, are not offered as a means for the accurate prediction of the heat evolution of a commercial cement of indefinite history, used under any given conditions. But for the conditions under which they were determined they show the heat effects of the major clinker compounds that are believed to be formed; and, to the extent to which it may be assumed that the same order will be maintained under altered conditions, they show in general the relative effects of these compounds. Although other factors enter, to modify the heat evolution of an actual commercial concrete, yet it is the chemical compounds that are responsible for that evolution, and a knowledge of their relative contributions under definite conditions is the first essential in the design of more suitable cement compositions for use where this property is important.

Summary and conclusions

The heat evolved during setting and hardening was determined at 3, 7, 28, 90 and 180 days for a number of portland cements of varied composition. The cements were mixed neat, with 40 per cent of water, and were stored at 35 deg. C. (95 deg. F.) in sealed bottles. Heat liberation was determined by the heat of solution method. The results were analyzed by the method of least squares for the contribution of each per cent of each compound to the total heat evolution, on the assumption that there exists a linear relationship between the compound composition of a cement and its heat evolution. The compounds comprised in this analysis were:

Tricalcium aluminate, ($3CaO.Al_2O_3$)
Tricalcium silicate, ($3CaO.SiO_2$)
Tetracalcium alumino-ferrite, ($4CaO.Al_2O_3.Fe_2O_3$)
Beta-dicalcium silicate, ($2CaO.SiO_2$)

The following conclusions applicable to the conditions maintained in the experiments are drawn from this study:

1. Portland cements continue to evolve heat during hardening for a period of six months, and probably longer.

2. A considerable portion of the heat has been evolved at the end of three days, and the order of sequence for different cements that obtains at that time is in general maintained throughout the six-month period.

3. Pronounced changes in the proportions of the cement raw mix, and hence in the compounds present in the clinker, produce marked differences in heat of hardening. (Of those cements in this series for which complete six months' data are available the range at three days is from 41 to 91 calories per gram, and at six months from 73 to 116 calories per gram.)

4. The compounds, ranked in descending order on the basis of the heat evolution during the first three days, have the same sequence in which they were enumerated above, first $3CaO.Al_2O_3$, then $3CaO.SiO_2$ (considerably lower in heat evolution), and finally $4CaO.Al_2O_3.Fe_2O_3$ and $2CaO.SiO_2$ with relatively small values quite close together. Considering the latter two as occupying practically the same position, the above order is maintained at the later ages.

5. The predominant values for the tricalcium compounds and the close agreement between those for the other two compounds permits the heat evolution of fresh cements, similarly prepared, to be estimated on the basis of the former compounds alone. Thus, for the experimental cements the function (per cent $3CaO.SiO_2$) + 2.1 (per cent $3CaO.Al_2O_3$) exhibits good correlation with the heat evolution.

The heat evolution may be estimated with equal accuracy either from the calculated percentages of the various compounds or directly from the analysis of the cement expressed in terms of the oxides. The constants have been given for both methods.

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Airplanes Carry Machinery for Dredges and Power Plant

Instead of building 90 miles of mountain road through tropical jungle to reach a gold-bearing gravel deposit in New Guinea, the Bulolo Gold Dredging Co. utilized an airplane to transport the material and machinery for two dredges with buckets of 10-cu.ft. capacity and a hydro-electric plant to supply power for the dredges. This unusual development in heavy transportation by air is described in a paper by Charles A. Banks read before the British Institution of Mining and Metallurgy. Frank W. Griffin, San Francisco, Calif., was consulting engineer for the dredge design.

At some extra cost the dredges were sectionalized, so that when knocked down no separate part would weigh more than 7,000 lb., this maximum weight being that of the upper tumbler shaft. Supplies and exploration equipment had been taken in by a local air-transport company, using airplanes carrying loads up to 2,000 lb. An airplane company decided that it could adapt a standard triple-motor machine to carry 7,000-lb. loads, a roof hatch enabling the cabin to be loaded by a crane. During the twelve months ending with March, 1932, two airplanes carried 2,500 tons in monthly quantities increasing from 35 to 350 tons as the force became more accustomed to loading the airplanes.

From Lae, the coast port, to Bulolo the flying distance for the round trip is 100 miles. With a flying time of only 75 min. the normal 3½-hour supply of gasoline could be reduced so as to increase the cargo capacity from 5,800 lb. to the required 7,000 lb. Airplanes of an all-metal type were used, each having a cargo compartment 24x6½ ft. and 5 ft. 9 in. high, with roof hatchway 12x5 ft.

In a comparison of cost Mr. Banks gives the capital cost of the planes and their operation (exclusive of amortization) at $732,000. To this may be added $10,000 as the additional cost for sectionalizing the dredges, and $20,000 as extra cost of erection, making a grand total of $762,000. The cost of the 90-mile road was estimated to be $1,000,000, with $75,000 for hauling equipment and $125,000 for transportation and road maintenance, or a grand total of $1,200,000. Furthermore, the dredging was begun at least a year sooner than if the road had been built, its time of construction being estimated at twelve to eighteen months.

Record-Size Cableway for Hoover Dam

Installation with 150-ton capacity and 1,200-ft. span to handle penstock pipe and generating equipment will be by far largest in world—Drop of 605 ft. between loading and unloading platforms—Plant to be two-speed electrically operated

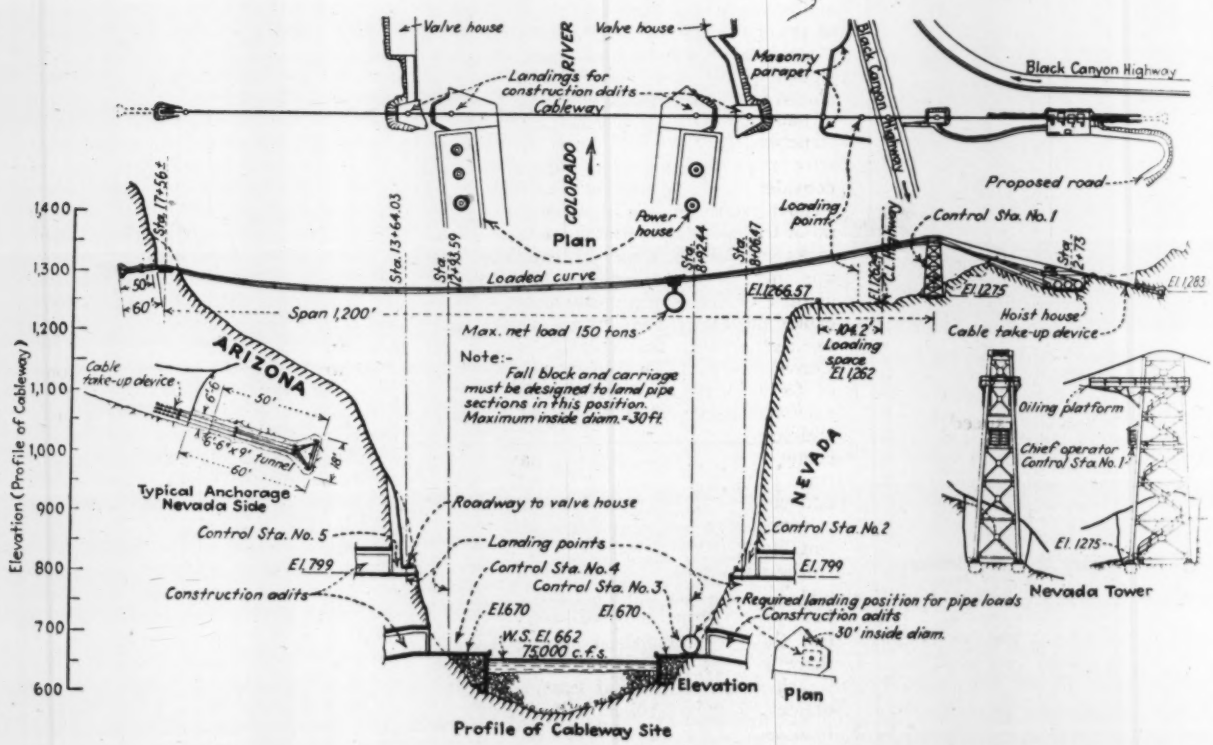
PROPOSALS have been received for the installation of the largest-capacity cableway in the world, capable of handling 150 tons, as a permanent piece of equipment at Hoover Dam. The cableway will span Black Canyon just below the power house site, from the rim of the Nevada side to a point high on the Arizona canyon wall. It will be supported by a structural steel tower on the Nevada side, but will connect directly with a tunnel anchorage in Arizona territory. The hoist house and loading platform will be in Nevada.

The cableway will handle all of the 30-ft. diameter and smaller penstock pipe, sections of which will weigh 150 tons (*ENR*, July 21, 1932, p. 79), all power plant equipment, gates, valves and other heavy machinery or equipment between a point at El. 1262 on the Nevada rim and four landing platforms, two on each side of the river near the bottom of the canyon at El. 670 and El. 799. The cableway will consist of a track made up of a number of horizontal steel-wire cables connected at both ends to eyebars embedded in concrete anchors. The hoisting machinery, all electrically operated, will be located between the tower and the anchor on the Nevada side. Operating at a speed of 240 ft. per min., the carriage will have a total travel of 1,050 ft. The load speed for hoisting and lowering will be 30 ft. per min. when raising loads of from 40 to 150 tons and for lowering loads of from 50 to 150 tons, and 120 ft. per min. for raising or lowing lighter loads. Provision will be made for creeping speeds when conveying and inching speeds when hoisting or lowering. Five control stations are required, control station No. 1 being located on the tower for the chief operator, who will direct the conveyance of the load to a point over each of the other four stations. Control will then be transferred to the desired station at one of the four landing platforms, where a local operator will direct the lowering or raising of the load, with ability to convey the load at a creeping speed within a restricted zone. Direction of operations by the chief operator will be by means of a telephone connected to all stations. Transfer of control between stations will be made with all equipment de-energized, and resumption of operation will be made by means of a definite interlock to the station assuming control.

Control apparatus will be so arranged that all operations, including hoisting, lowering and conveying, can be controlled at station No. 1 by means of a change-over switch located in the hoist tower. Signal lights will be provided at each station showing which stations are energized. Operation and control will be by direct current supplied by a motor-generator set, the primary power supply being alternating current delivered at 2,200 volts, three phase, 50 or 60 cycles.

The entire installation will be ready for operation within 135 calendar days after notice is given to proceed with the work. Liquidated damages at the rate of $200 per day have been set for the time exceeding the contract limit.

The government will do all the excavation necessary for the anchors, tower footings, saddles, hoist house and backstay clearance. Concrete foundations for the hoist equipment, tower footings and saddle, and the concrete



Plan and profile of government's 150-ton cableway installation at Hoover Dam. This installation will be permanent and takes the place of the inclined railroad originally planned for handling heavy equipment from the top to bottom of Black Canyon.

and steel anchorages will be installed by the government. The government will also erect the hoist house with a crane runway, install a traveling crane in the hoist house and will transport all machinery and material for the cableway from the factory shipping point to the end of the government-built railroad near the site. Transportation will also be furnished for contractor's equipment and tools from the contractor's warehouse to the site and back as far as Boulder City. The contractor will furnish and erect all other equipment required by the cableway installation, and will furnish the anchorage steel.

Operation requirements

The first four years of service will consist principally in the lowering of fabricated sections of welded steel pipe, the main sections of which will be 30 ft. in diameter and 12 to 23 ft. long. About 46,000 tons of pipe sections will be lowered from the canyon rim and deposited on landing platforms at the entrances to two adits on each side of the river, as shown on the accompanying illustration. There will be a total of 38,000 tons of maximum-size pipe sections to be handled during the four-year period, and the cableway will have a capacity to lower one 150-ton section to station No. 4, raise one such section from station No. 4 and deposit it at station No. 1, then lower another section to station No. 3 or No. 4, at the lower speed, as a continuous operation, allowing a 10-min. interval for loosening and making connections. The cableway will also have a capacity for raising loads up to 40 tons and lowering loads up to 50 tons at the higher speed and transporting them between any of the five stations continuously for six hours, allowing a 5-min. interval for making connections. Miscellaneous loads of from 1 to 85 tons will be handled between the loading point on the Nevada side and a roadway being constructed on the Arizona side at Sta. 16 + 50. Beginning with the second year of operation, the cableway will be used for lowering generating machinery for the power plant, and gates, valves and other miscellaneous machinery for the outlet work, for which the heaviest piece will weigh 80 tons. Thereafter the cableway will be used for general maintenance purposes.

Capacities and speeds

The net load capacities, exclusive of the weight of the carriage and fall blocks, and the speeds will be as follows: lowering 50 to 150 tons and raising 40 to 150 tons, 30 ft. per min., with two inching speeds for picking up or landing loads; lowering loads up to 50 tons, and raising loads up to 40 tons, 120 ft. per min., with two inching speeds for picking up or landing loads; conveying speed of 240 ft. per min., for all loads at proper acceleration when starting, deceleration when approaching any station, and with provision for suitable creeping speed.

Hoisting equipment

The hoist bearings will be mounted directly on the bedplate, with a pit in the foundations for that part of the drums extending below the floor line. Each drum of the hoisting and conveying equipment will be driven by its own individual motor. The conveying and hoisting drum will be of such diameter and length as to wind the rope in a single layer with three spare coils on each end, with diameters and speeds so proportioned that when the load is in the upper position it will not be raised or lowered in relation to the track cables when conveying the carriage.

Brakes—The hoisting equipment will be equipped with heavy-duty service and emergency brakes designed with a liberal factor of safety for operation in either direction, with ability to sustain full load under all conditions of operation, including interruption to the power supply. Regenerative braking will be provided for restraining the lowering of heavy loads. Dynamic braking will be provided to decelerate loads before service brakes are applied, and will operate when failure of the power supply occurs, in which event the service brakes will automatically function. The service brakes, of the solenoid-operated spring-set type, connected to an extension of the motor shaft, will have ample power to decelerate promptly and to hold the maximum load. An emergency brake will be provided on each hoist drum, held in released position during normal operation, designed to decelerate and hold the maximum load in the event of overspeed or other emergency.

Cables and Ropes—Track cables designed with a safety factor of 3, will be placed in a horizontal plane and will be of super-plow steel, lang lay, 6x37 construction, with a steel wire strand or wire rope center. Backstays will be considered as permanent installations. Proper provision will be made for take-up of track cables by means of hydraulic jacks or reeved tackle, threaded take-ups not being allowed. To insure against twists during installation, track cables will be marked with a red stripe as they leave the closing machine. Conveying and hoisting rope will be of 6x19 construction, with a factor of safety of not less than 4½. Ropes 1½ in. and smaller in diameter will have hemp centers, and larger ropes will have wire rope or strand centers. The hoisting and conveying ropes will be supported at intervals of not more than 100 ft. by suitably arranged carriers.

Carriage and Fall Block—Carriage and fall block are designed for a load of 150 tons, with a factor of safety of not less than 5, and are so arranged that there will be no turning of the load. Track rollers will be at least 24 in. in diameter. Each roller will develop a load not in excess of 7,400 lb. on the track cable. The fall block will be designed to carry the load by means of a single pin and links, and will be in stable equilibrium with no load. The design of the carriage and fall block is arranged to carry the large pipe sections with their axis horizontal and at right angles to the track cable.

Saddles—Track cable saddles will be of steel and will be grooved for the cables, having an arc of contact that will provide proper support and long life for the cable. The radius of the saddles will be not less than 75 times the diameter of the track cables. Pinned connections in lieu of saddles will not be allowed.

Track Cable Anchors—Anchors at both ends of the cableway will be of the mushroom type, consisting of a 6½x9-ft. tunnel leading into a chamber 18x18x10 ft. in size. The overall length of the portion filled with concrete will be about 50 ft.

Tower—The structural steel tower on the Nevada rim will be about 25 ft. square at the base, and will be designed with a factor of safety of 5 plus an allowance for impact stresses produced by one-quarter of the lift of the load, and will be high enough to permit a 30-ft. diameter pipe section to clear the parapet wall at the loading point. An inclosure with glazed front, to house the equipment in control station No. 1, will be incorporated in the tower at an elevation that will permit full view by the chief operator of all loading operations at that station.

Motors—Motors will be of the direct-current, separately excited, shunt-wound type for reversing service and will drive the hoist drums through reduction gears and flexible couplings. A separate hoist motor will be provided for each hoist drum. Double extended shafts for electric brakes and brake wheels on the end opposite the flexible couplings will be provided. Thermal overload relays will protect the motor from heating.

Control system

The control apparatus will provide for two systems of motor operations as follows: system A—a selective remote-control system with operations controlled as desired from any one of the five control stations; system B—a remote-control system with all operations controlled from control station No. 1.

A change-over switch will be provided as part of the control equipment in the hoist house for changing from one system of control to the other. Control for station No. 1 will be of the indoor type, and for the other four stations will be of the outdoor protected type, with a telephone for directing operations and a signal system by which colored lights will show which station is energized. Under either system of control, failure of power will cause the motor brakes to set and will also introduce an auxiliary dynamic braking circuit on the main-hoist motor circuits.

Control System A—Normal operation will permit the chief operator at control station No. 1 to pick up the load and send the carriage to a point over any of the other four stations as selected. The control will then be transferred to the selected station, where the operator at that station will lower and raise the load with provisions for conveying the load at creeping speed within a restricted zone. Selection of high or low speeds for raising or lowering loads will be made by the chief operator at station No. 1. When a lowering load reaches a predetermined point above the landing, the speed will be decelerated, with further inching to final deposition of the load under control of the local operator. Proper provision will be made for acceleration at high or low speeds for picking up a load at any station, and for raising or lowering the carriage at the high speed at any time or position. When the fall block has reached the upper limit of travel at any station, control will be taken over by the chief operator at station No. 1. Interlocks will be provided to afford protection against overlapping of any functions between control stations.

Control System B—Under this system all operations will be under the control of the chief operator at station No. 1 by means of a multi-point master controller with selector switches to provide for conveying or hoisting and lowering. Limit switches will guard against overtravel of the carriage at either end of its run. Operation may be governed by means of either telephone or hand signals. Under this control system the cableway will be operated for handling miscellaneous loads between the loading point on the Nevada side and the roadway to be constructed on the Arizona side.

The cableway was designed in the Denver office of the U. S. Bureau of Reclamation under the direction of R. F. Walter, chief engineer. Installation will be under the direction of Walter R. Young, construction engineer of the Bureau of Reclamation, in charge of the Hoover Dam project.

Special Low-Heat Cement for Pine Canyon Dam

CEMENT prepared under specifications providing for material reduction in the heat of hydration, as compared to the average standard cement, will be used in the construction of the Pine Canyon dam, which is being built by the water department of Pasadena, Calif., on the San Gabriel River. Requirements for the cement include: (1) the cumulative heat of hydration must not exceed 65 cal. per gram of cement at the age of 7 days, and 80 cal. at 28 days; (2) tricalcium aluminate must not exceed 6 per cent by weight; and (3) the fineness is to be 85 and 98 per cent on the 200-mesh sieve. Standard-mortar compression specimens are to show 2,000-lb. strength at 28 days, but the 28-day strength is to be at least 35 per cent higher than the 7-day strength.

This phase of the Pine Canyon project marks a distinct advance in the progress of modern mass-concrete construction and results directly from recent investigations on fundamental problems of cement characteristics. It is the first time that definite requirements on heat generation have been written into cement specifications based upon the present knowledge of cement chemistry. The specifications for the special cement are outlined in the following.

The Pine Canyon dam, which will provide a main storage reservoir for the water-supply system of Pasadena, is of gravity design with straight crest. The design includes provision for resisting an earthquake force with an acceleration of 0.1 gravity. The structure will be about 325 ft. high above the lowest point in the foundation and 275 ft. thick at the base; it will contain 450,000 cu.yd. of concrete. Thus it is of a mass that brings into the foreground the problem of heat generation during setting.

Consideration of heating phenomena and the resulting stresses in this mass of concrete, in the light of recent progress made in the technology of cement, led to the preparation of special specifications for the cement. Realizing the difficulties involved in specifying a product that was a distinct departure from the accepted standard, those in charge of design and preparation of specifications cooperated with representatives of local cement companies on the details of the specifications. From a considerable group of special types of cement originally suggested, final specifications called for bids on three types. The first was for standard A.S.T.M. specification cement, while the two others were for special cements.

The second alternate, for a special cement called type B, set up the following detailed specifications:

[It] shall conform to the requirements of the standard specifications for portland cement (serial designation C9-30) of the American Society for Testing Materials, with the following exceptions and additions:

The residue on a standard No. 200 sieve shall not exceed 15 per cent by weight, nor be less than 2 per cent by weight.

The cumulative heat of hydration of the cement shall not exceed 77 cal. per gram of cement up to the age of seven days after mixing with water, and shall not exceed 90 cal. per gram of cement up to the age of 28 days after mixing with water.

The third alternate was a special cement referred to as type C, which was required to meet the following detailed specifications:

The cement to be furnished under alternative proposal No. 3, hereinafter called type C cement, shall conform to the requirements of the standard specifications for portland cement (serial designation C9-30) of the American Society for Testing Materials, with the following exceptions and additions:

(1) The percentage of tricalcium aluminate shall not exceed 6 per cent by weight, when computed from the cement analysis by the method of Bogue as published in the Analytical Edition, *Industrial and Engineering Chemistry*, Vol. 1, No. 4, p. 192, Oct. 15, 1929.

(2) The residue on a standard No. 200 sieve shall not exceed 15 per cent by weight, nor be less than 2 per cent by weight.

(3) No requirement shall be placed upon the tensile strength of standard mortar briquets.

(4) The average compressive strength of not less than 3 cylindrical test pieces, 2 in. in diameter and 4 in. in length, composed of mortar containing 1 part cement and 3 parts standard Ottawa sand, by weight, when tested in accordance with the tentative standards for compressive strength of portland cement mortars (serial designation C9-16T) of the American Society for Testing Materials, shall be equal to or higher than the following:

Age at Test, Days	Storage of Test Pieces	Compressive Strength, Lb. per Sq.In.
7	1 day in moist air at 70 deg. F. 6 days in water at 70 deg. F.	800
28	1 day in moist air at 70 deg. F. 27 days in water at 70 deg. F.	2,000

The average compressive strength of standard mortar shall be at the age of 28 days at least 35 per cent greater than the strength at the age of 7 days.

(5) The cumulative heat of hydration of the cement shall not exceed 65 cal. per gram of cement up to the age of 7 days after mixing the cement with water, and shall not exceed 80 cal. per gram of cement up to the age of 28 days after mixing with water.

The cement is to be furnished in bulk, except in small quantities that may be required in sacks, at a rate of delivery not to exceed 2,000 bbl. per day. Specifications require that no cement shall be shipped from the mill until it has satisfactorily passed the 28-day tests specified for the particular type of cement.

A joint bid of four local cement companies named the following delivered prices: $1.56 per barrel in bulk, or $2.16 ($1.76 net) in sacks, for type A.

and $1.65 in bulk, or $2.25 ($1.85 net) in sacks, for types B and C. Delivery was to be at the dam site in bins provided by the contractor.

In view of the advantages to be realized in the use of a cement with a heat of hydration that will be about two-thirds that of standard cement at seven days, and the resulting effect on the concrete mass during the process of setting and subsequent cooling, type C cement was selected and will be used for the main mass of the structure. The price differential of 9c. per barrel was believed to be considerably less than the advantage to be obtained by using the special cement. According to the specifications, the special low-heat cement need not be used in thin sections or accessories to the main structure.

Determination of the heat of hydration by the heat-of-solution method is made under the following procedure: samples of 300 grams of the dry cement, representing composite samples from each 1,000-bbl. lot, are taken and kept sealed until tested. The cement sample and 120 grams of distilled water are mixed at a temperature of 70 deg., with mechanical stirring for 5 min., and then placed in equal amounts in four or more containers. Each container is sealed, stored at 70 deg. F. for one day, and then maintained at 100 deg. F. until tested. At the age of 7 and 28 days the heat of solution of two specimens of the partly hydrated cement is determined by the heat-of-solution method in a given acid mixture. Also, two determinations of the heat of solution of the dry cement are made in an identical acid mixture not later than the date of the 28-day test on the hydrated samples. The heat of hydration at the age of seven days is determined by subtracting the average heat of solution of the two specimens of cement hydrated for 7 days from the average heat of solution of the two specimens of dry cement. Similar determination is made for the heat of hydration at the 28-day period.

The heat of solution, either dry or hydrated, is determined by dissolving a known weight of the cement in a dilute nitric-and-hydrofluoric-acid mixture and observing the resultant temperature rise.

Design and construction of the Pine Canyon dam is under the direct supervision of S. B. Morris, chief engineer and general manager of the Pasadena water department, with C. E. Pearce as designing engineer and Ross White as construction engineer. Louis C. Hill and F. A. Noetzli are consulting engineers. Prof. Raymond E. Davis, University of California, is consulting engineer on the preparation of the cement specifications and control. Ivan L. Tyler will be in charge of the concrete testing and control for the city. The cement companies that joined to furnish the special cement are Riverside Cement Co., Southwestern Portland Cement Co., California Portland Cement Co. and Monolith Portland Cement Co.

Large Addition Being Made to Iowa Hydraulic Laboratory

CONSTRUCTION of a large addition to the laboratory of the Iowa Institute of Hydraulics Research, University of Iowa, at Iowa City, was undertaken early this year. The present laboratory and the architect's sketch of the ultimate structure are shown in the accompanying illustration. The addition now under construction is the central block 105 ft. long and five stories high.

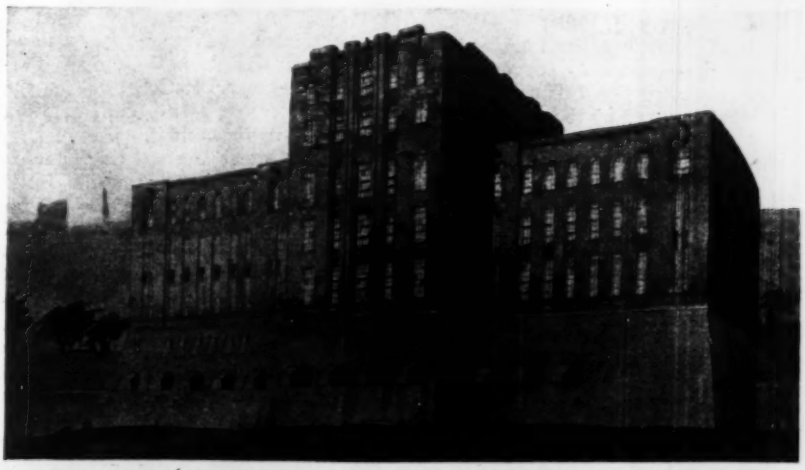
The hydraulic laboratory had its beginning in the river canal unit constructed at one end of the university dam in 1921. The exceptionally large supply of water available for experimental purposes soon attracted to the laboratory a schedule of research which overtaxed the available canals, and in 1928 they were supplemented by the addition of a three-story structure with a water supply circulated by pumps and designed primarily for the testing of small models and hydraulic machinery.

The laboratory structures are being developed upon the principle that the prime requisites for a building in which to study hydraulic phenomena are adequate length and height with a minimum amount of fixed structure, so as to afford ready adaptability to a large variety of temporary apparatus. The new addition will extend the main river canal to a total length of 311 ft., and will provide a total height of 90 ft. above the level of the lowest canal floor. The addition also will more than double the present operating floor space.

A head of 10 ft. is available at the dam, and a flow of 1,500 sec.-ft., with a low flow of 100 sec.-ft. The maximum capacity of the canal is 1,000 sec.-ft. The main canal has a length of 311 ft. and a width of 10 ft., and the auxiliary river canal has a width of 16 ft. and a length of 120 ft. The largest diameter of piped supply is 48 in. The laboratory pumps have a capacity of 25 sec.-ft. under a 50-ft. head, and the measuring basins range from 1,000 to 30,000 cu.ft. in capacity.

Floyd A. Nagler, professor of hydraulic engineering at the University of Iowa, is director of the Institute of Hydraulics Research.

The laboratory of the Iowa Institute of Hydraulic Research (below) is being extended by the addition of the five-story central block shown in the architect's sketch of the completed structure (above).



Regional Water Problems at N.E.W.W.A. Meeting

Fifty-first annual convention devotes its attention to questions of stored-water quality, Springfield's new supply, taste and odor problems, metering and distribution

Engineering News-Record Staff Report

OF PARTICULAR importance to the New England region, the questions involved in collecting, purifying and distributing water that is soft, of low turbidity and high color served as the subject of discussion at the 51st annual meeting of the New England Water Works Association at Springfield, Mass., Sept. 27 to 30. Thirteen papers were presented at four half-day sessions, which were given over to discussions of Springfield's water supply, metering and distribution, taste and odor control and the quality of impounded supplies, respectively. The New York section of the American Water Works Association met jointly with the New England association.

At the close of the convention it was announced that new officers had been selected as follows: Richard H. Ellis, president; E. Sherman Chase and Howard M. Ellis, vice-presidents; Roger W. Estey, Harry U. Fuller and Warren J. Scott, directors, and Albert L. Sawyer, treasurer. A communication to the Reconstruction Finance Corporation was approved by the meeting, urging that the extension of federal credit facilities for self-liquidating waterworks projects be expedited to provide some measure of relief for unemployment during the coming winter.

Springfield water supply

Springfield's present water supply is drawn from the Little River. A diversion dam forms an inlet reservoir from which the water is led through a mile-long tunnel to the slow-sand filter plant located 14 miles west of the city. Herbert F. Salmond, chemist of the filter plant, presented a description of the purification works.

The plant consists of a control house, a sedimentation basin, an aerator and ten filter beds, together with the necessary conduits and sand-storage bins. Alum is added to the water as a coagulant to effect a reduction in the water's color, which averages 37.5 p.p.m. The sedimentation basin has an area of 10 acres and a capacity of 42 m.g., providing a detention period of two to three days. Automatic valves at the portal of the inlet tunnel, housed in the control house, keep the basin filled.

The aerator consists of two fountains, 18 and 24 in. in diameter, respectively, placed in a 50-ft. diameter pool. The depth of the pool is 10 ft. The height of water on the filters is controlled by this aerator. A weir is provided to care for excess flows.

A total filter area of 6¼ acres is provided in ten units. All are 260 ft. long and 12 ft. high, six are 91 ft. wide, and four are 143 ft. wide. A center drain runs the entire length of each filter, with twenty lateral drains entering it from each side. Over the drains are placed 12 in. of graded gravel and 42 in. of sand, having an effective size of 0.30 mm. and a uniformity coefficient of 2.3. The effluent flow is controlled by a gate in the wet-well houses. Alternate scraping and raking of the filter sand surface is employed. The initial rate of filtration is 3 m.g.d. per acre; this decreases as the sand pores become clogged; and when the loss of head through the filter is 6 ft., the sand is scraped or raked. In scraping, 1½ in. of sand is removed.

The plant has been in operation since 1910. In that time the color reduction has been from an average of 37.5 to an average of 17.6 p.p.m. Of 6,593 presumptive tests for B. Coli made on the filtered water, only two, both in 1910, gave positive indications.

To supplement the existing Borden Brook storage reservoir on the Little River drainage area, Springfield has recently completed Cobble Mountain dam. It is a hydraulic-fill structure which impounds a reservoir having a capacity of 22.8 billion gal. and an area of 1,134 acres (*ENR*, Sept. 24, 1931, p. 507). A paper describing the new dam was presented to the meeting by Harry H. Hatch, resident engineer in charge of its construction.

Power from Cobble Mountain dam

In connection with the Cobble Mountain development the Turners Falls Power and Electric Co. has constructed a hydro-electric power plant a short distance downstream from the dam to utilize the head between the reservoir and the bed of Little River at the point of discharge. A description of the power development was presented in a paper by Herbert A. Moody, hydraulic engineer of the power company.

There is an agreement between the power company and the city of Springfield that gives the company under a 30-year lease all the power it can generate at the plant and storage capacity in Cobble Mountain and Borden Brook reservoir amounting to a maximum of 2.9 billion cu.ft. The gross head from the flashboard crest at Cobble Mountain to the minimum tailwater at the power plant is 460 ft. The power company must pass through the plant sufficient water for the city's use and cannot draw down the Cobble Mountain reservior level below certain elevations that are stipulated for each month. The maximum storage capacity given is that above the March elevation. Additional storage capacity of 3 billion gal. below the power tunnel intake can be made available to the city by opening the gate of the diversion tunnel. The agreement further provides that the minimum allowable reservoir elevations are to be raised when the water consumption of Springfield reaches 20 m.g.d., with further raises thereafter as the city demand increases.

The power plant is located so that its wheels discharge directly into the intake reservoir of the purification plant. When it is operating at capacity it is expected that the maximum effective head at the wheels will be 420 ft., and will develop 33,000 kw. Under minimum conditions the head will be 330 ft. and the power output 23,000 kw.

The plant is tied in with other power stations of the Western Massachusetts Co., both steam plants and run-of-river hydro plants. The Cobble Mountain development, because of the large amount of storage, will be used to carry the power peak through the low-river-flow season of the year. The record week of minimum river flow would produce at the run-of-river plants 875,000 kw.-hr. per week, and during such a week these plants would operate on the extreme top of the load curve. The maximum capacity obtainable from these plants would be 34,000 kw. The 63,000 kw. of steam capacity during such a week of minimum flow would carry the base of the load, leaving a balance of 23,000 kw. to be obtained from the plant at Cobble Mountain.

Impounded supplies

Although the Connecticut River traverses the entire length of New England from north to south, there is not a single public water supply taken directly from it. Impounded supplies are the rule, and the use of upland waters and large storage reservoirs is increasing year by year, not only in New England but in the neighboring eastern states. A summary of the quality characteristics of stored water was contained in a paper prepared by H. P. Eddy, consulting engineer, of Boston.

Natural conditions of topography and geology, as well as the conditions of population on the watershed, govern the quality of the water to be drawn from an impounded reservoir. Color of the water is dependent largely upon topographical conditions of the drainage area, such as the extent of swampy

areas. Hilly agricultural land is likely to yield water of high turbidity. The topography of the reservoir site itself is also of importance, as a reservoir with shallow flowage will be a favorable spot for the growth of algae, and a long narrow reservoir will facilitate short-circuiting, especially if the axis is paralled to the direction of prevailing winds. The most satisfactory reservoir is one with steep slopes and relatively greater depth of flow. The chemical character of the rock formations predominating on the watershed governs the chemical characteristics of the water impounded. Because of the infrequent occurrence of calcareous rock, New England waters are soft.

The amount of organic matter in the reservoir water determines largely the degree of its color. As the organic matter is consumed, however, the color gradually decreases. Stripping of the reservoir site aids in reducing the color; without stripping, the water will be less desirable for the first fifteen years or so. Long storage has a beneficial effect on the supply. The water is reduced in turbidity by sedimentation, it is bleached by sunlight, and odor-and-taste-producing substances are reduced. Within a month or two bacteria are killed off.

Manganese in reservoir water

Although the condition is not so serious as with groundwaters, manganese can cause a great amount of trouble when present in reservoir water. Its presence is largely due to the acids produced by decomposing vegetation dissolving compounds of manganese from the soil. Unfortunately, it reacts with orthotolodine to give the same brown color that is indicative of chlorine residual, so that chlorination control is seriously interferred with. A recital of experiences with manganese in connection with reservoir water was contained in a paper prepared and presented by Robert Spurr Weston, consulting engineer, of Boston.

Tests on the water in the Wanaque reservoir, in northern New Jersey, show that the amount of manganese in solution cannot be explained by the small amounts in the tributary streams. Manganese increases steadily in concentration from top to bottom, reaching a maximum at the very bottom. This is taken to indicate that the decomposing vegetation on the bottom of the reservoir is the most serious contributor of manganese. In that reservoir the manganese content has been gradually decreasing since it was put into service nearly two years ago, but it suffered a sudden and sharp rise at the time of the fall overturn.

Water distribution

Three papers were presented at the meeting dealing with the subject of water distribution and consumption. The first, by Harold W. Griswold and W. A. Gentner, of Hartford, Conn., was entitled "Domestic Flow as Affecting Meter Registration and Water Revenue." As preliminary tests on old meters taken directly from service indicated the possibility of appreciable under-registration at the lower rates of flow, 24-hour records of consumption rates were secured from a number of typical two- and three-family houses in Hartford. A recording instrument was used consisting of a revolving-chart on which a line was traced by a pen actuated by the meter disk spindle. Results showed that in houses equipped with tank toilets, from 27 to 50 per cent of the total consumption is used at rates less than 1 gal. per minute, and that 38 to 78 per cent is at rates less than 2 gal. per minute. In houses with flushometer toilets the percentage of use at low rates is somewhat less. It is concluded that the accuracy of meter registration at rates less than 2 g.p.m. is of great importance.

The data secured led to the conclusion that for houses with tank toilets, from 7 to 12 per cent of the consumption is not recorded, resulting in revenue losses (at 20c. per 1,000 gal.) of $0.43 to $2.58 per meter per year. Losses are higher in homes equipped with flushometer valves. If the average yearly loss for all $\frac{5}{8}$- and $\frac{3}{4}$-in. meters is taken as 50c., the revenue loss on this class of meters alone in Hartford is $11,000 per year. It is thought that the loss may run as high as 5 per cent of the total revenue.

"Experiences With Water-Main Cleaning" was the title of a paper presented by Arthur T. Clark, division engineer, Greenwich Water Co., Greenwich, Conn. Mr. Clark pointed out that results at Greenwich indicated that the costs of cleaning were less than the resultant savings in operating costs. In regard to the time a main is out of service, he stated that the time can be greatly reduced by incorporating into the design of the system provisions for easy insertion of the cleaning machine. Seven miles of main have been cleaned at Greenwich, with a total out-of-service time of five hours.

A. Prescott Folwell, editor of *Public Works*, New York, gave a progress report of statistics that he is collecting regarding water consumption in American cities. A marked feature of the results to date is the wide variation in per-capita consumption. Even among the larger cities represented in the compilation, per-capita consumption varies from 192 gal. per day in the case of Buffalo to 72 gal. per day in Knoxville. The ratio of maximum-hour consumption to average-daily consumption varies from 7.53 in Natick, Mass. (population 13,400) to 1.42 at Bloomington, Ind. (population 18,000).

New water-treatment practices

Much attention has been given during recent years to methods of improving coagulation by more adequate mixing devices. R. S. Rankin, of The Dorr Co., New York, in a paper entitled "The Mechanical Conditioning of Treated Waters," described a new piece of equipment known as a "flocculator," invented by Marsden C. Smith, of Richmond, Va. This device is a paddle mixer comprising a horizontal shaft and a number of parallel paddle blades held in place by radial arms. It is capable of incorporation into an existing plant by being installed at the entrance to the settling basin. The approved method of installation is to set the shaft across the direction of flow through the current (*ENR*, Sept. 22, 1932, p. 363).

F. E. Stuart, research engineer of the Industrial Chemical Sales Co., New York, described the application of powdered activated carbon to water purification. Unlike most chemicals used in water treatment, activated carbon is insoluble, and its work is done by adsorption of unstable organic compounds in the water. Mr. Stuart stated that it has been found that the addition of activated carbon along with the coagulant facilitates floc formation and improves the subsequent sedimentation; it inhibits the putrifaction of the settled sludge; it reduces the chlorine demand of water by adsorbing much of the organic matter, and it makes the residual chlorine hold to a more constant figure in prechlorination.

Efforts at taste prevention at East Providence, R. I., through the use of the ammonia-chlorine treatment, were described by James T. Turner, superintendent of the water plant in that community. East Providence is provided with a raw water that is inferior bacterially, being polluted by sewage and the drainage from swampy areas. The water is purified by six tub filters, in conjunction with alum coagulation, settling and chlorination. At present both ammonia and chlorine are added to the water prior to filtration, with a distance of 75 ft. between the two points of application. The chloramines produced have resulted in a prevention of after-growths in the distribution system and a much more uniform water. It has been observed that adequate time must be allowed the orthotolodine test for residual chlorine, or the results will be misleading. A ratio of 1 to 3 has been used in the application of ammonia and chlorine.

Aeration, another widely used process for the reduction of tastes and odors, was discussed by Herman B. Anderson, of Vogt Bros. Manufacturing Co., Louisville, Ky. He gave particular attention to the diffusion method of aeration, as examplified by the device known as Aer-O-Mix. This apparatus works by drawing air into the water as it flows down a vertical tube. The air is in the form of a great number of small bubbles, presenting a very large interface area for the transfer of oxygen into the water and the sweeping out of taste-producing volatile compounds.

Engineering News-Record

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Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England.

Subscription price $5 per year in the United States; foreign rates on application.

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OCTOBER 6, 1932 Volume 109 Number 14

Progress Still Slow

TWO additional public works loans were made by the Reconstruction Finance Corporation last week, following the first loan, that for the Colorado River Aqueduct. To date, therefore, some 50 million dollars have been made available for employment out of the 1½ billions entrusted to the corporation for the revival of public construction under Title II of the Relief Act. This amount may be increased by some further approvals by the time the present paragraph reaches the reader, but even so it is a disappointingly small showing for ten weeks of activity. Compared with the conditions that existed before the passage of the Relief Act, it means progress; compared with the tremendous power of the resources placed in the hands of the corporation and the magnitude of the emergency to be met, it is negligible. But more rapid action is expected in the next week or so, and if this hope can be realized the R.F.C. may yet succeed measurably in reducing the unemployment burden of next winter.

A Special Case

ONE of the new R.F.C. loans, financing the New Orleans belt bridge against repayment in part through other than toll revenue, should not raise false hopes as to the possibility or repaying other R.F.C. loans in a like manner. The combined highway and railway bridge of the New Orleans Public Belt Railroad is a special case provided for in a clause written into the Relief Act in general terms, but for the specific purpose of making it possible for the R.F.C. to finance that structure. This clause applies only to structures whose financing "in part by taxation" was authorized by laws passed prior to the date of the Relief Act, July 21, 1932. It is possible that one or two exceptional cases might come under the clause, but in general the act as passed permits of no possibility of getting R.F.C. loans for highway or bridge construction unless refunded from revenues and charges alone.

Relief to the Fore

TO ASSURE that the Relief Act will be made effective as an employment measure, it is important that the essential character of the act as a relief act be kept in dominating position. Some of the Washington authorities look upon the act as a banking measure and not a relief measure—a mere convenience in financing rather than an agency to create employment and lay the foundation for business recovery. This view clashes irreconcilably with the intent of the legislation and with the open facts of the existing emergency. Very properly, therefore, a resolution voted last week by the New England Water Works Association, expressing grave concern over the disappointing progress made by the Reconstruction Finance Corporation in loans for self-liquidating construction, lays emphasis on the relief character of the act by saying: "The expressed intent of the Relief and Construction Act is to stimulate public-works construction in order to help relieve unemployment and to revive normal trade." Unless this same view animates all who are concerned with the act—the corporation as well as the officials of communities who can put the fund to work—the act is bound to fail. The spirit of the resolution claims the full support of engineers and their organizations in order that the act may effectively bring relief.

Entitled to Support

WHAT was said at the Pittsburgh meeting last week on the responsibility of the engineer and administrator in the public service is well worth noting. The public-works official labors under severe difficulties in these trying times, and is entitled to support. He performs vitally essential service, and must do so despite pressure from opposing groups, the one clamoring for reduction of expenditures and the other demanding increased service. Meanwhile the official is keenly alive to the fact that he has the public's investment to protect, that the comfort, efficiency and health of the community are in his trust and that not merely value but also the prevention of disaster depends on the faithfulness and thoroughness of his performance. The building official, for example, who through leniency or neglect should allow sub-standard construction to be carried out might easily set the stage for a future calamity through collapse or conflagration. The public official has conducted himself well in a time of stress. Honor and support to him, rather than denunciation and reproach.

Remedy At Hand

BID SHOPPING or peddling continues to operate as a destructive force in the field of contracting, materials and equipment. Its ruinous effects in bringing losses to producer and subcontractor and in degrading the quality of work are well-known; yet headway against the practice is imperceptibly slow. Possibly bid peddling will persist until the volume of construction increases sufficiently to make the present-day buyer's market less dominating. In the meantime it is profitable to remember that determined adherence to the practice of single-price bidding is a complete remedy. While a single firm cannot apply it, local or regional groups can do so, if every member appreciates its value and adheres to it consistently. So essential a principle, however, should receive country-wide recognition. At Washington next week when the Associated General Contractors, the Construction League and the National Conference on Construction will be in session, there is opportunity to put back of this principle a force of powerful influence toward establishing it throughout the industry.

Improving Research Facilities

IN VIEW OF the modest proportions of American research work in the larger problems of applied hydraulics, there is ground for satisfaction in the enlargement of research facilities at the Iowa hydraulic labora-

tory. Important work has been done there in the past, but much wider possibilities reside in the extension of size and scope through an enlarged investigational plant. The range of practical questions involved in hydraulic construction has long been beyond the reach of existing laboratories, and while the new institutions at Vicksburg and Washington contribute fundamentally to filling the gap, they can manifestly do only part of the work needed by advancing practice. Moreover, the spirit of inquiry and discovery of truth must be nurtured in many places if adequate progress is to be made, and opportunity for independent research effort in numerous centers is vital to this purpose. The growth of the Iowa institution is welcome not only because of what it means for that laboratory alone but also because of the stimulus it will give to the development of hydraulic research plant at other centers of learning.

Increased Power

AN ADVANCE of prime importance is recorded in the clay subsoil grouting at Madden Dam. The methods worked out there by ingenuity and patient persistence add distinctly to the engineer's power over unfavorable subsoil condition. Another instrument has been created for coping with the threat of underground fissures and seams, long one of the most formidable hazards in many fields of civil engineering construction. Unseen, often unsuspected, difficult to explore and still more difficult to deal with, such openings or water-bearing seams constituted virtually hopeless obstacles to safe construction until cement and asphalt injection methods were brought to success. The achievements of these methods in recent years are familiar, and continued work at ever more difficult problems is steadily increasing their range of effectiveness. With the practical development of clay injection, a still broader field is opened for the control of underground water passages. The final success of the full-scale work at Madden Dam therefore will open a new chapter in the history of subsoil work.

One Way to Save

FOR a full year the low building-cost level has held out opportunities for profitable investment, but just now these opportunities are greatest. Recognition of this fact doubtless played a part in pushing ahead the New York housing projects. Industry at large has even more to gain by utilizing the opportunity than has a housing corporation, for the capital costs of industry bear on every unit of this future production and for years will determine its place in competition. Industry, therefore, is chiefly concerned in knowing that now is the psychological moment for saving in plant investment. The rise in material prices has not yet gone far enough to affect costs noticeably, but its influence may soon increase sharply. Labor costs are at a bottom figure, with wage rates at their minimum and efficiency at a maximum. Under these circumstances the large total of plant rebuilding needs that has accumulated since 1929 holds out a real challenge to industry, as well as to finance, its handmaiden. Many plants that were on a fair competitive basis three years ago may find themselves outdated when the test of close competition in an active market again comes around. Rebuilding then will be costly. Rebuilding now can save a decisive item of cost bearing heavily on the chance of profit or loss.

Mass-Concrete Developments

UNMISTAKABLE evidence indicates that important developments in the field of mass concrete may bring marked change in construction practice as well as in engineering thought. Recent researches in cement chemistry hold out the promise of definite progress toward effecting control over cracks caused by the heating and subsequent cooling of mass concrete. It is still too early to say that the problem has been entirely solved, but enough has been accomplished to indicate that the results may be awaited with much confidence.

In some respects the recent progress suggests a partial return to earlier practice. Concrete dam construction in the 1890's utilized the cement of that day, an excellent material. Though it was high in heat-producing constituents, its slow strength development combined with coarse grinding and the slow rates of dam construction tended to keep the heat of the mass to a point where cracking was not a serious problem. In those days the significance of heat effects was little appreciated, but the great masses of modern dams have brought these effects to the focus of attention.

By popular demand the characteristics of cement have been gradually modified in recent years to produce high strength with quick rise. A marked increase in early heat of hydration inevitably followed, and this, combined with the astonishing increase in speed of dam construction—often as much concrete is placed in one day as was placed during a month's construction in earlier days—creates a serious problem. More total heat, decreased opportunity for heat dissipation because of faster construction and the increased mass of the structures now designed have all aggravated the difficulty.

The problem of cracking was first attacked by the development of the grouting process, which has progressed to a remarkable degree. But, this, of course, affords a cure and not a prevention. Only recently has attention been turned to the underlying problem of limiting heat generation and temperature rise, from the realization that expansion due to the heat of hydration of the cement followed by contraction during the subsequent cooling was the fundamental cause of the difficulty. Appreciation of this fact led to the present study of methods for the reduction of heating tendencies. Among the natural first attempts in this direction was the limitation placed on the height and rate of succession of the lifts in massive construction, and the use of slots to accelerate the dissipation of heat.

Meantime, in the technical field of cement research, active thinking has been in progress on the more fundamental study of heat-producing constituents and how they could be reduced and yet leave a suitable cement. This fundamental research was greatly stimulated by the problems involved in Hoover Dam and the proportions of the concrete mass involved in that structure. One of the first definite examples of the progress made is the research carried on at Riverside and the call for low-heat cement for the Pine Canyon Dam.

It is evident that the problem of cracking in mass concrete has been attacked on a logical front with telling effect. The progress already made is essential to the future of dam construction, with the inevitable demand for larger structures. If this progress can soon be supplemented by equally fundamental research and improvement in placing concrete, even more far-reaching advance in the quality of construction will be accomplished.

NEWS OF THE WEEK

Engineer Examiners From Many States Meet in New York

A SYSTEM of national registration of engineers, put into effect experimentally earlier this year under sanction of the National Council of State Boards of Engineering Examiners, received formal endorsement by the council at a meeting held in New York Sept. 22-24. Headquarters for the National Bureau of Engineering Registration have been established at Columbia, S. C., under the immediate direction of T. Keith Legaré, secretary of the council. The work of the bureau is administered by a committee headed by Hugh A. Kelly, secretary of the New Jersey Board, in conjunction with an advisory committee appointed by national engineering societies. At the New York meeting Secretary Legaré reported that so far only about a dozen applications for national registration had been received and about half of these had been completed because of the thoroughness of the examination of the applicant's record made by the bureau.

Some opposition to the establishment of the National Bureau developed at the New York meeting, chiefly on the grounds that acceptance of the certificates of the national bureau by state boards would amount to an illegal delegation of authority, also that such a bureau might develop into a "racket." Hugh A. Kelly, chairman of the committee, in answering both questions, pointed out that no state board is obliged to accept certificates of the national bureau, that the certificates are issued chiefly to assist them in passing upon applications, also to assist individual engineers by simplifying the procedure of having their records presented to the several state boards. He said further that in view of the fact that the bureau's administrative setup calls for its complete control by officers of the council and requires that its advisory board consist of prominent engineers outside the council effectively precludes its control getting into the hands of men whose chief interest in it would be the collection of fees.

Professional developments

During the discussion of the national bureau, David B. Steinman, president of the council, pointed out that when the movement for the establishment of the bureau was first proposed it was recommended that it be but the start of a larger movement for setting up a definite program for engineering training beginning with the student in college, prescribing educational and training requirements before he could receive his certificate of registration and giving him the full status of a professional engineer. Now, however, as a similar movement inaugurated by the American Society of Mechanical Engineers has progressed to the point where four of the major engineering societies and the Society for the Promotion of Engineering Education have endorsed the movement

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New York City Not Permitted To Tap Underground Water

The New York State water control commission, on Sept. 30, ruled that New York City may not go into Nassau County to draw an additional water supply of 69 million gallons daily from the underground supply of that section of Long Island. The attorney-general, in giving out the commission's decision, stated that New York City can go to the Delaware River or to other sources open to it by law whereas Nassau County must depend entirely on its own resources, the limit of which is not yet known. He stated further that no engineer has been able to prove to the satisfaction of the commission how much water is available in Nassau County or to prove that the source is other than from rainfall. A drain such as New York City proposes, he said, ultimately might cause salt water to reach the present well supplies of Nassau County.

A decision as to whether New York City may increase its well capacity in the boroughs of Brooklyn and Queens by an additional draft from the underground supply of 27 million gallons per day will be rendered by the commission at a later date.

A governing point affecting the commission's decision, the attorney general stated, is the fact that the commission cannot set a time limit in its grant, it must be in perpetuity. While there is ample water now to supply all needs, ultimately Nassau County will need all the available water. When that time comes it could not cancel New York City's permit.

The increase in draft from the underground supplies were proposed to be made by the city to supplement its present supply before going to the Delaware.

San Francisco Sells Bonds For Construction Work

Sale of $2,394,000 municipal construction bonds by San Francisco to a local bank on a bid of $2,400,713 at 4½ per cent interest will put several hundred men at work by November. About $1,000,000 of the funds will be used for constructing two new units to the San Francisco Hospital for which plans have been approved. Of the remaining money, $731,000 will go for the building of a new county jail and $588,000 will be used for boulevard work.

On the same day the city sold $2,160,000 of its $6,500,000 relief bonds recently voted at a bid of $2,163,456 at 4½ per cent interest.

Baltimore Improvement Bonds Not to Be Put to Vote

A bond issue of $22,000,000 for schools, sewers, paving, conduits, and a new court building in Baltimore will not be put to vote at the November election, according to a decision of Mayor Howard W. Jackson, following a conference of bankers, business men and municipal officials. So far as possible city improvements are to be kept on a pay-as-you-go basis.

R.F.C. Loan Policy Will be to Ask High Rate of Interest

NO INTEREST rate of less than five per cent has been allowed thus far on projects approved by the Reconstruction Finance Corporation. This reflects the desire of the corporation to retire from the banking business at the earliest possible date. When loans are granted it is made very clear that they can be lifted at any time at par and accrued interest.

Because of the hard-and-fast requirement in the law that all loans must be fully and adequately secured, the officials of the corporation apparently feel that the junior money should constitute at least one-third of the cost of the project.

Until very recently there was great doubt in the minds of officials of the corporation as to the existence of any great number of sound projects that had not secured the money needed from private sources but that point of view is changing. A large number of apparently sound self-liquidating projects are appearing on the horizon. This is mainly due to the cooperation of local interests anxious to provide employment.

Technicalities delay action

At the present time the neck of the bottle at the Reconstruction Finance Corporation is the legal division. There are no precedents to follow. Most legal questions that arise have to be worked out in their entirety. Most of this work, however, will expedite the consideration of other projects as they come along. It was fully expected that the application for the New Orleans bridge could be passed upon within a few days. Instead it took weeks. The bonds had been approved by a large investment establishment, yet the legal staff at the R.F.C. found ten holes that had not been plugged by the lawyers for the banking house. It was possible to act much more promptly on the application of the Metropolitan water district of Los Angeles because there were few legal questions involved.

Circular No. 3 revised

Circular No. 3 setting forth the regulations which govern applications for self-liquidating projects is to be rewritten in less formidable language. Some additions also will be embodied in the circular and suggestions will be made for the best procedure to follow in securing preliminary consideration of a project. Any applicant who is in doubt as to the eligibility of his project will be asked to submit a preliminary statement before incurring the expense incident to the proper preparation of a formal application.

More projects reported

Application for a loan of $450,000 for the construction of a municipal power plant for the city of Fayetteville, N. C., has been authorized by the board of aldermen.

Perry, Okla., plans to apply to the R.F.C

for a loan of $75,000 to complete the municipal gas distribution system.

Construction of a waterworks system to cost $100,000 is proposed by the borough of Somers Point, N. J., if the money can be obtained from the R.F.C. The town of Linwood, N. J., also contemplates the construction of a waterworks system at a cost of $180,000 if money can be obtained from the R.F.C.

Formal application for a loan of $1,750,000 was made to the R.F.C. by the city of Davenport, Iowa, for the construction of the Bettendorf-Moline bridge across the Mississippi River.

Construction of a sewer system is proposed by the city of Hopkinsville, Ky. The city has applied to the R.F.C. for a loan of $325,000.

Repairs to the sewer system of the town of McGhee in Arkansas at a cost of $45,000 is proposed if the money can be obtained from the R.F.C.

Water for suburban Washington

Application for a loan of $250,000 has been made to the R.F.C. by the Washington Suburban Sanitary Commission. The commission proposes to build a 10 million gallon pumping station at Burnt Mill and a 2-mile pipe line from the Patuxent River. The application asks for an interest rate of 4½ per cent and repayment in 20 years.

The present plant of the commission has a capacity of 4 million gallons per day and the peak demand on the system reached 7 million during one day in August.

Thirty-five communities in Arkansas have applied to the R.F.C. for loans ranging from $10,000 up to $300,000 for sewers and extension of waterworks systems, and other municipal work. Among the large items are $300,000 for sewers at Little Rock and $200,000 for the same purpose at Texarkana and $100,000 for sewers at Batesville. Many items for paving are included although there is no indication that paving will be accepted by the R.F.C. as coming under the self-liquidating class.

Application for a loan to construct a bridge from a point near Popes Creek in Charles County, Md., to Dahlgren, Va., was decided upon at a recent meeting of officials of the two states. Organization of a company to construct the bridge and operate it is proposed. The bridge would cost approximately $3,000,000, would have a clearance of about 76 ft. above high tide and a lift span to give a maximum clearance of 100 feet.

State housing projects

Five states now are actively planning to pass housing laws under which they can obtain loans from the R.F.C., according to American Engineering Council. They are Ohio, Illinois, Massachusetts, Indiana and Pennsylvania. Loans can only be made to limited-dividend corporations such as authorized by the New York State law. Plans for housing projects are in preparation in Chicago, Cleveland, Cincinnati, Boston and Washington, in addition to those in New York.

Problems of the Readjustment Period Discussed by Public Works Officials

THE ECONOMIC READJUSTMENT and its relation to the public works official was the subject of three important addresses at the thirteenth conference of the International Association of Public Works Officials held in Pittsburgh, Pa., Sept. 29-Oct. 1. Louis Brownlow, director, Public Administration Clearing House, Chicago, told the conference that public works officials would be subject to opposing pressures, on the one hand for reduction of expenditures, and on the other for increased services. He said that even waste elimination on the part of public works officials would be met by opposition because public opinion was not ready for the expert who might abolish inefficiency. Mr. Brownlow urged public works officials to meet the economic readjustment by improvement in management and technique.

In part Mr. Brownlow said: "It is a most important duty of the public works official to improve his understanding of the general problem of government to see if he can better interpret his problems to the public.. We are facing a boycott on government. There should be a concerted effort to improve the prestige value of public affairs so that the public will look with the same deference upon the heretofore despised, quiet, unobtrusive public official, as it has in the past upon success in private business."

I. G. Gibbon, principal assistant secretary of the Ministry of Health of England, said that in his country they had been faced with the depression problem for ten years past. He told of the methods used by public works officials to reduce expenditures and maintain service, and mentioned, in this connection (1) the introduction of "controlled tipping" (intelligent dumping in America) as the main achievement of the Ministry of Health in public cleansing in recent years, (2) propaganda directed to the householder to reduce the quantity of refuse to be collected and disposed of, (3) placing the work under persons specially qualified to direct public cleansing, and (4) the introduction of a system of comprehensive cleansing cost records.

Carl Schneider, New Orleans, La., in a paper on the economic readjustment, said: "I am firmly of the belief that we need not expect any permanent lowering of taxes; they are going to increase as a process of evolution. The day is coming when the levying of taxes will be used as more than a means of obtaining revenues to meet governmental obligations. It will have to be used principally as a social instrument, a means to ultimately provide stabilization in national industry. In times of prosperity, taxes must be levied much beyond the point required for current necessary expenditures."

Efficiency of street cleaning

Harrington Place, engineer of the Detroit Bureau of Governmental Research, speaking on efficiency of street cleaning in relation to reduced budgets, said that the equipment dealers of the Public Works Association could perform a real public service by formulating plans by which officials could purchase equipment on a monthly payment plan. "The present situation will call for wiser planning, more intensive application and more strenuous

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Lidgerwood Low Bidder for Hoover Dam Cableway

The Lidgerwood Manufacturing Co., Elizabeth, N. J., submitted the low bid of $172,110 for the installation of the 150-ton capacity cableway to be erected by the government at Hoover Dam. Bids were opened by the U. S. Bureau of Reclamation at Denver on Sept. 26. Other proposals received were: Washington Iron Works, Seattle, $172,950; Consolidated Steel Co., Los Angeles, $194,000; McKiernan-Terry Corp., New York, $210,000 and John Roebling's Sons, Inc., Trenton, $240,000. It is expected that formal award of the contract will be made shortly in Washington. A complete description of the cableway is given on page 408 of this issue.

Pine Canyon Dam Included In Los Angeles Aqueduct System

Pine Canyon Dam, now under construction by the city of Pasadena, Calif., is to be included as part of the distributing system of the Colorado River aqueduct supply for southern California, according to an agreement reached between the city of Pasadena and the Metropolitan Water District of Southern California on Sept. 24.

As noted in last week's issue, the city of Pasadena had called a special election to be held Oct. 1 to determine whether or not the city would withdraw from the Metropolitan Water District. The election was called in order to force a determination before Oct. 2 as to whether or not the reservoir formed by the Pine Canyon Dam would be taken over by the Metropolitan Water District. In the agreement reached on Sept. 24 it is provided that no bonds obligating Pasadena will be sold by the water district until a contract for joint storage in the Pine Canyon reservoir has been signed. The contract will provide that the water district will take over the Pine Canyon project when Colorado River water is available for Pasadena.

Delayed Highway Work Resumed

Work on fourteen road surfacing contracts in Louisiana totalling 210 miles which was stopped because of lack of funds has been resumed. Contracts ranged from 33 per cent to 80 per cent completed when the work was held up.

Plans for Third Flood Dam at Los Angeles Abandoned

Abandonment of plans to build a third flood-control dam in San Gabriel Canyon and the continuance of the policy of securing and developing land for storing of flood waters underground has been recommended to the Los Angeles county board of supervisors by its engineers. The contemplated third dam would not add to flood protection and geological conditions at the site are unfavorable, according to the report of Louis C. Hill, consulting engineer.

The county is now building San Gabriel Canyon No. 2 dam and is seeking bids on the construction of No. 1 dam. Both are financed through the sale of bonds, of which approximately $6,500,000 remaining available would have been used for the contemplated third dam.

Maryland Highway Work to State Contractors Only

In a call for bids on the construction of concrete shoulders on certain highways in Maryland, the Maryland State Roads Commission has announced that only bids from contractors who are residents of Maryland or from corporations the majority of whose outstanding stock is held by residents of Maryland, will be accepted. Only residents of the state are to be employed on the work.

This action has been made possible by the fact that all the funds used for the particular work in question are state funds.

Pre-qualification of the bidders will be required. On road work contractors will be required to pay a minimum hourly wage of 35 cents for unskilled labor with increases of from 25 to 50 per cent for semi-skilled and skilled labor. A minimum of 25 cents an hour is specified for unskilled labor on the bridge work included in the bidding.

Engineer Examiners

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and have appointed representatives on an "Engineers Council for Professional Development," Dr. Steinman recommended that the council join in that movement. A vote on the proposal was taken and approved. D. B. Steinman, T. Keith Legaré and Dean P. H. Daggett, Rutgers University, were named to represent the council on the new body.

The model law for registration of professional engineers and land surveyors, revised April 15, 1932, was approved by the council.

Rating of engineering schools

Dean Daggett presented to the council for its consideration a suggested schedule for rating engineering schools. At the present time there is no national rating of engineering schools. The American Society of Civil Engineers maintains a list for the confidential information of its own directors, and the regents of the University of the State of New York publishes a list of schools it recognizes. Recommendation of the committee that the proposed rating schedule be submitted to the Engineers Council for Professional Development was approved.

State registration law

Secretary Legaré in his annual report pointed out that there are now 25 states having license laws for engineers who are members of the council, the latest addition being Wisconsin. Illinois, where only structural engineers are licensed, and New Mexico and Texas where only surveyors are licensed are not represented. He stated further that license laws are under consideration in Connecticut, Illinois, Ohio, Washington, Delaware and the District of Columbia. In all, 30,000 registered engineers are now represented by the council. Seventeen states were represented at the New York meeting.

At the closing session of the council O. Laurgaard, city engineer, Portland, Ore., was elected president of the council for the ensuing year and A. B. Clemens of the Pennsylvania Board was elected vice-president. Mr. Legaré was reelected secretary-treasurer.

American Transit Association Succeeds A.E.R.A.

On Sept. 28 the American Electric Railway Association, at its annual meeting at Chicago, voted to change its name to American Transit Association. Its affiliated organizations (engineering, accounting, claims) changed their names correspondingly, the former American Electric Railway Engineering Association becoming the American Transit Engineering Association.

The change in name reflects the broadening field of activity of urban transportation companies, most of which now operate not only electric railway cars but also buses and in some cases taxicabs. During recent years integrated transportation service has been an important subject of consideration at the A.E.R.A. meetings. The new name was therefore adopted in order to express more correctly the field and interests of the organization. A corresponding change was made by the Canadian Electric Railway Association last June.

At the meeting, which brought together about 300 members, Walter A. Draper (Cincinnati Street Ry.) was elected president. The following were elected vice-presidents: W. E. Wood (Engineers Public Service Co., New York), Frank Phillips (Pittsburgh Ry.'s Co.), Edward Dana (Boston Elevated Ry.). The secretary (Guy C. Hecker, New York) was reappointed.

An interesting account of research work was presented in an address by C. F. Hirshfeld, Detroit Edison Company, on investigations in car design. The studies dealt with noise and passenger comfort. As to noise, they indicated that the chief source is the non-resilient wheel running on steel rails, tending to set up high frequency vibrations within the car structure. Development of resilent wheel construction as a remedy is in progress. As to passenger comfort, the experiments showed that lateral movement is more objectionable than longitudinal or vertical movement, and that change in acceleration is more disturbing than acceleration itself.

Committee on Construction In Congress Proposed

Proposal to set up a standing committee on construction in each house of Congress is to be considered at the meeting of the governing board of the Associated General Contractors of America to be held in Washington Oct. 10-11, Edward J. Harding, managing director of the Association, has announced. Although under the present setup there are at least 17 standing committees which regularly consider and frame legislation directly affecting the construction industry, there is none, Mr. Harding points out, that considers problems of the industry as a whole.

Beauharnois Hydro in Operation

Operation of the first unit of the Beauharnois hydro-electric power plant on the St. Lawrence river above Montreal was begun on Oct. 1. Filling of the 15-mile canal was undertaken some time ago. It is 3,380 ft. wide between dikes with provision for a deep navigation channel at one side.

The initial installation in the power plant is 260,000 horsepower.

Public Works Officials

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action to obtain the desired results. It seems we are in for a period of more efficient operation."

H. P. Eddy, Jr., of Boston, speaking on locating an incinerator and meeting the objections of the citizens in a practical way, urged publicizing the incinerator project as a superior method of municipal housekeeping. By proper location of the incinerator and attention to architectural details, the incinerator can be made an asset rather than a liability, he said.

Street and sanitation records

The committee on uniform street and sanitation records, Joseph J. Petranek of Cicero, Ill., chairman, reported that complete installations of the association's model public works records and cost accounting procedure had been completed in Cincinnati, O., Lexington, Ky., Newport, Ky., Binghamton, N. Y., and Covington, Ky. The committee hopes to publish by January its guide for preparing annual public works reports. The committee recommended that the association go on record approving the work done and recommending to the members that they adopt the system in their individual communities.

Donald C. Stone, staff director of the committee on uniform street and sanitation records, reported on his four-month visit to Europe, during which he was a delegate to the International Congress of Local Authorities in London and the British Institute of Public Cleansing. He said 121 cities out of 219 used "controlled tipping" for refuse disposal in 1930 in England.

D. H. Sawyer, director, Federal Employment Stabilization Board, U. S. Department of Commerce, advised long-range planning as a natural extension of the budget system and recommended schedules of public works 5 or 6 years in advance, with annual revisions and named as advantages of such planning: Proper location of projects; defense of policy of public works departments; proper sequence of projects; advance knowledge to utilities; avoidance of duplication; spreading construction through the year; and facility in budgeting.

Samuel A. Greeley, of Pearse, Greeley & Hansen, Chicago, speaking on sewage disposal, stressed the usefulness of operating data in preliminary studies of sewage treatment projects and exhibited slides showing collected operating data pertinent to the four salient features of preliminary study of such a project: population, quantity of sewage, character of sewage, and character of receiving body of water.

New officers elected

Carl Schneider, mechanical engineer, Division of Public Works, Department of Public Property, New Orleans, La., was elected president of the association. Other officers elected were: Thomas L. Costigan, superintendent of street cleaning, Washington, D. C.; Mark B. Owen, commissioner of public works and engineering, Dearborn, Mich.; and Alfred E. Roche, commissioner of public works, Troy, N. Y., vice-presidents. P. J. Hurtgen, director of public works, Kenosha, Wis., and A. M. Anderson, of Chicago, Illinois, were re-elected treasurer and secretary respectively.

The registration at the conference was 120, including 25 from Pittsburgh. The 1933 conference will be in Milwaukee.

Decision in Suit Over Piles At Lake Charles Appealed

An appeal to the Louisiana Supreme Court from the adverse decision of the U. S. District Court in the Lake Charles breach of contract case is to be made by the contractor, P. Olivier & Son. The case grew out of the discovery of defective creosoted piles in a dock built for the Lake Charles Harbor and Terminal District by the contractor and his refusal to replace them. The district court's decision was abstracted in the Aug. 11 issue of *Engineering News-Record*, p. 209.

The case has attracted wide attention because of the technical questions involved, the litigation centering chiefly around the way in which the creosoting of the piles was carried out.

Boston Technical Relief Bureau Seeks Funds To Continue Work

A plea for funds in order to enable it to continue its work has been sent out by the Emergency Planning and Research Bureau sponsored jointly by the Boston Society of Architects and the Engineering Societies of Boston, Inc. John F. Pierce, executive director of the engineering division, reports that together the engineering and architectural divisions directly employed 376 of the 1,262 applicants and found positions for 171 others. At the peak of employment last April the two bureaus were employing 240 men and were spending $3,600 per week. Overhead expenses were kept so low that 96 cents of every dollar went directly into relief.

Without competing in any way with the work of architectural and engineering firms the bureau has assembled and classified a mass of information. Long needed maps for which funds have never been available, have been made for state institutions. Over $11,000 has been spent on this work, work which would have required about $56,000 under normal methods of appropriating money. Reports on housing conditions and property valuation, also maps showing streets and properties by types, worth at least $55,000, have been prepared and turned over to the City Planning Board.

During the latter part of the summer, in order to conserve funds, the number of employees was reduced to about 170 and the weekly pay, through the employment of men in shorter hours, has been reduced from the original amount of $15 to about $9.

Cut in Highway Program of New Jersey Ordered

A cut of from $300,000 to $500,000 in the $19,000,000 highway construction program for the state of New Jersey has been ordered by Governor Moore as part of his campaign to reduce state expenditures. The Governor has urged the State Highway Commission to spread the saving out as much as possible over its entire program rather than cut off whole items of work, also to introduce staggered working hours as an economy measure rather than cut the number of its employees.

Economic Problems of the Profession Discussed by A.A.E.

ADVANCEMENT of the social and economic welfare of engineers and the rôle they should play in relieving the depression were considered from various angles at the eighteenth annual convention of the American Association of Engineers held in Washington Sept. 26-28.

To develop new markets for surplus products and to create new products to displace imports is an engineering job that, in the opinion of Henry Arnstein, consulting chemist of Philadelphia, is essential to economic reconstruction of the United States.

Declaring that this country no longer can rely upon foreign trade to absorb the surplus production of industry and agriculture because of the post-war resolve of every nation to become economically independent, Dr. Arnstein stated that it is up to the engineer to divert excess commodities into new uses, to exploit and manipulate natural resources to supply products now lacking, to enlist the cooperation of bankers in developing quicker and cheaper transportation and refrigeration and to teach the consuming public to prefer and to meet their requirements with domestic products.

"I do not preach selfishness," said Dr. Arnstein, "but I do believe that if we have ten million men out of employment our duty is first to alleviate their suffering, create for them employment and after their essential requirements have been satisfied, to lend a helping hand to the unfortunates of foreign countries. Americans should primarily benefit by America's natural resources and this will depend on the imagination, intelligence and ingenuity of the American engineer."

Registration for Washington

Enactment by Congress of an engineer registration law for the District of Columbia was advocated by the convention, following a report by C. J. Ullrich, chairman of the committee on the subject. The proposed draft for the district differs principally from the laws already enacted by 28 states in that registration of surveyors is rendered unnecessary by the fact that under existing legislation all surveying work is done through the surveyor's office.

Vocational guidance in engineering was discussed by J. A. L. Waddell, of New York City. As chairman of the committee on engineering education Dr. Waddell has prepared a textbook on vocational guidance for use in high schools that is designed to check the heavy scholastic mortality among college engineering students who did not have a proper foreknowledge of the qualifications necessary for advancement in the engineering profession.

A report by William B. Douglass, chairman of the standing committee on engineering law, revealed that many engineers have turned to invention to tide them over the depression. Mr. Douglass described the difficulties encountered in patent law and procedure but stated that because of his natural intuition and professional training, the engineer has the requisites of a successful inventor. The services rendered by the association to professional engineers were described by Erle K. Ramsey, retiring president. Construction of public works, tax rates, and the aims and problems of the Reconstruction Finance Corporation were discussed by V. Bernard Siems, of New York, and John Lyle Harrington, member of the engineering advisory board of the R.F.C.

Clausen medal awarded

The second Clausen gold medal for distinguished service in behalf of the social and economic welfare of engineers was presented to Herman A. Wagner, of Chicago, for seven years a director and officer of the association. Dr. Wagner's most spectacular work for increasing the recognition and compensation of engineers was his lively crusade against dishonest and inefficient technical correspondence schools.

V. H. Housholder, of Phoenix, Ariz., was elected president, succeeding Erle K. Ramsey, of Oklahoma City. D. L. Chamberlin, of Washington, was elected vice-president, and Victor E. Baum, of Tulsa, Okla., and Howard A. Levering, of Ceredo, W. Va., were elected directors.

Inspection trips to the Bureau of Standards, the Department of Commerce, Washington Navy Yard, Mt. Vernon, a banquet and dance were the principal features of the entertainment program arranged by the Washington chapter.

Work on New Orleans Bridge Expected to Start in November

Construction work on the Public Belt railroad and highway bridge across the Mississippi River above New Orleans is expected to get under way in November. As noted last week, the Reconstruction Finance Corporation has agreed to bid for the bonds necessary to construct the bridge in order to insure a purchaser. Under the arrangement arrived at with the R.F.C., the Louisiana Highway Commission will advertise for bids for $7,000,000 in gasoline-tax-supported bonds for 30 days as required by law. The R.F.C. will bid par for the issue. It will bear interest at 5 per cent. Simultaneously, the city of New Orleans will offer $6,000,000 of bonds supported both by the assets of the municipally owned Public Belt Railroad and by a mortgage on the structure itself. Interest upon the bonds is expected to be derived from the railroads using the bridge.

A year ago bids were taken on construction of the bridge and contracts predicated upon the ability of the state to sell the bonds were awarded as follows: Siems-Helmers, Inc., substructure of the main bridge, $3,083,185; American Bridge Co., New York, superstructure of main bridge, $2,618,670; McDonald Engineering Co., substructure of approaches, $496,337; McClintic-Marshall Corp., New York, superstructure of approaches, $3,226,789.

Highway Users Conference Appoints R. F. Britton Director

Roy F. Britton of St. Louis has been appointed director of the Highway Users Conference. Mr. Britton is a lawyer and an expert on highway transport.

The Highway Users Conference has been organized to collect and correlate data on motor transport in order to assure to the road-using public maximum use and benefit without the hampering effect of burdensome taxes and punitive restrictions.

Personal Notes

PHILIP B. FLEMING, major, Corps of Engineers, U. S. Army, has been assigned to duty as assistant to the sector engineer at Kansas City. At present, Maj. Fleming is serving as an instructor at the U. S. Military Academy.

J. T. ELLISON, chief engineer and assistant commissioner of the Minnesota Highway Department, was elected president of the International Highway Association at its meeting held recently in Calgary, Alberta.

C. E. MYERS, consulting engineer, Philadelphia, Pa., and president of the Philadelphia Section, American Society of Civil Engineers, has been appointed a member of the Pennsylvania State Registration Board for Professional Engineers.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Pittsburgh, Pa., Oct. 20-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

HIGHWAY AND BUILDING CONGRESS participated in by fourteen national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

Obituary

MALCOLM R. MCADOO died at the University Hospital in Baltimore, Md., on Sept. 29. At the time of his death he was engaged in design work on the proposed canal across Florida. Formerly Mr. McAdoo practiced as a consulting engineer in New York.

SIMON LEOPOLD, president of the Lower Coast Construction Co. and of the Highway Construction Co., died recently at his home in New Orleans, age 70 years. For nearly half a century Mr. Leopold has been engaged in levee construction work in the Mississippi delta region.

ARTHUR P. MELTON, engineer member of the Indiana Highway Commission, died recently at his home in Gary, Ind., age 57 years. Mr. Melton studied civil engineering in Iowa State College but left to take up construction work with the Illinois Steel Co. in June, 1901. In 1906 he went with the Indiana Steel Co. to become assistant engineer in charge of townsite work and street construction at Gary, subsequently becoming city engineer. During the world war Col. Melton organized and commanded the 113th Engineers. He was appointed to the highway commission in 1929.

ROBERT TIBBETTS, 72, pioneer West Coast contractor on harbor work and engineering projects and an organizer of the Healy-Tibbetts Construction Co., died at his San Francisco home Sept. 27. In 1886 the two partners founded the well-known contracting firm; Mr. Tibbetts had been vice-president for many years.

Engineering Contracts and Capital

HEAVY ENGINEERING construction contracts reported during the past week total $27,093,000, far ahead of the weekly average of the last two months. Private work was unusually heavy, awards for this class totaling 7 millions, as compared with a weekly average of 2.5 millions for the last three months. Building contracts were also large, amounting to $11,300,000, of which $5,700,000 represents public buildings. Streets and roads contracts, which have been running 15 millions per week for the last three weeks, amounted to $11,700,000. Federal contracts totaled 3.2 millions. Large contracts awarded during the week include a petroleum refinery at Torrance, Calif., 1.5 millions; Pilgrim State Hospital buildings, Pine Aire, N. Y., 1.5 millions; Cincinnati post office, 1.7 millions, and the following state highway lettings: South Carolina, $1,122,000; New York, $1,752,000; Kentucky, $1,608,000 and Pennsylvania, $1,086,000.

New productive capital issues reported during the week total $14,769,000, all public issues except $561,000 private loans. The largest single issues of the week were: Baltimore public works, $2,963,000; Los Angeles schools, $1,536,000 and San Francisco public works, $4,554,000.

Large projects scheduled for early bidding include foundations, anchorages and cables for the Golden Gate bridge, estimated at 10.5 millions; a breakwater for Los Angeles and Long Beach Harbor, 7 millions and a state hospital at Gowanda, N. Y., 3 million dollars or more.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Oct., 1931	Sept. 1932	Week Oct. 6, 1932
Federal government	$ 4,705	$4,603	$3,198
State and municipal	21,823	15,673	16,888
Total public	$26,528	$20,276	$20,086
Total private	29,765	2,763	7,007
Week's total	$56,293	$23,059	$27,093
Cumulative, Jan. 1 to date:			
1931 construction			$2,021,407
1932			941,787

Decrease, 53 per cent.

NEW PRODUCTIVE CAPITAL

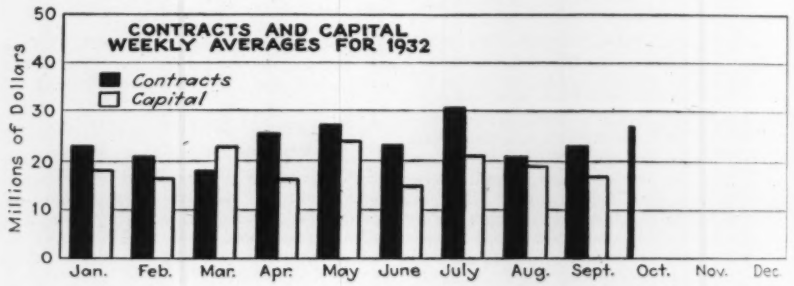
(Thousands of Dollars)

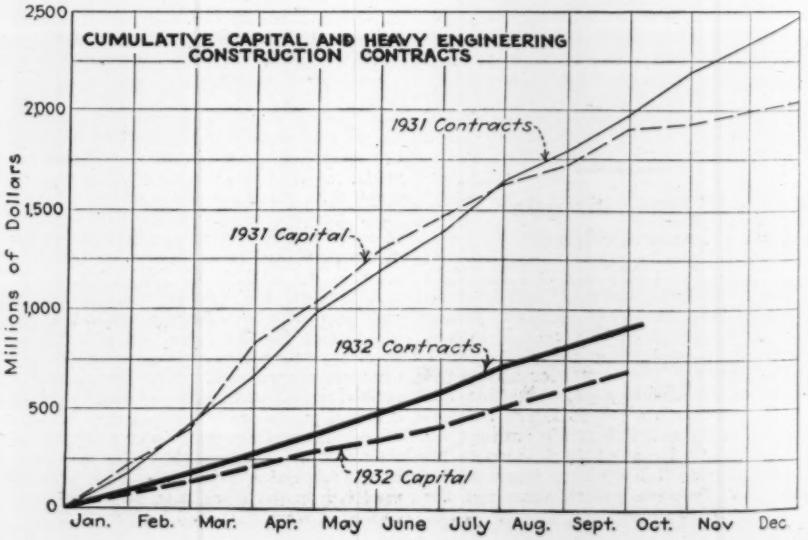
	Weekly Average Sept. 1931	Sept. 1932	Week Oct. 1 1932
Total private and public	$45,500	$16,500	14,800
Cumulative, Jan. 1 to date:			
1931 new capital			$1,942,500
1932 new capital			676,300

Decrease 65 per cent.

ENR Cost and Volume Index

Cost		Volume	
October, 1932	159.16	**Sept., 1932**	124
September, 1932	157.96	August, 1932	111
October, 1931	169.78	Sept., 1931	225
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

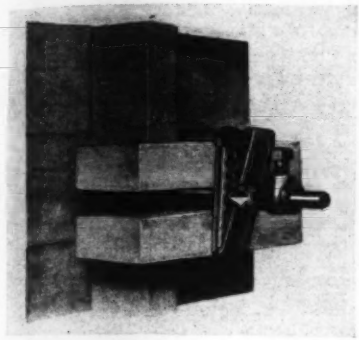




Construction Equipment and Materials

New Form Clamp for Concrete

A quick-action clamp for securing and clamping concrete forms is announced by the Frederick N. Ritchie Co., 113 North Centre St., Orange, N. J. The clamp consists of a tie member with a wedge-retaining element and a wedge cooperating with it for holding the forms in the assembled position. The Colt form clamp, so called, with the attached wedge is one unit, made of malleable iron and having cup pointed, case hardened set screws. The manufacturer states that the clamp can be applied in 15 seconds and that one blow of the hammer will clamp and lock the forms. The clamp can be used on ¼, ⅜, ½, ⅝ in. round rods or with wire.



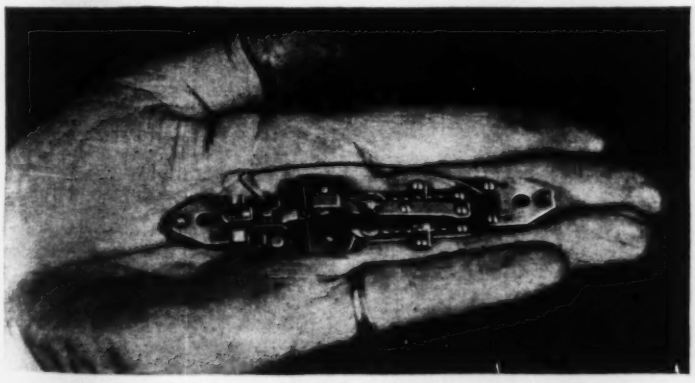
Colt form clamp

Extensometer of Small Size

An extensometer of unusually small size, weighing less than 1-oz., known as the "scratch" extensometer, is announced by the Baldwin-Southwark Corp., Philadelphia, Pa. A white diamond, especially cut, is mounted so as always to be under a small, but adjustable load. It bears on a target of specially heat-treated steel. The strain in the member under test causes the diamond to scratch a record on the target. Simultaneously the target is under a resultant force to move at right angles to the axis of the instrument. Strains are evaluated from the record by filar miscroscopes which may be of the moving eye-piece or of the moving-table type, or the record may be photographed microscopically and the print measured directly. With known magnification, strain becomes determinable.

The new instrument is no larger than a teaspoon and is readily fixed to members under load by a rubber band, by vacuum cups or by other methods.

New extensometer operates by causing a diamond to make a scratch on a target equal to the strain in the test piece. The magnitude of the record is then determined with a microscope.



New Equipment in Brief

Lift Trucks. The Lewis-Shepard Co., 125 Walnut St., Boston, Mass., has announced a new single-lift truck. The new lift truck comes in capacities up to 5,000 lb. Lift heights are 1⅜ in. or 2¼ in. The truck is so designed that it lowers the load forward and downward at the same time. When in load-raising position the handle is always connected to the load. Release from the elevated position is simple and easy.

Automatic Priming. A new automatically primed centrifugal pumping unit has been announced by the Worthington Pump & Machinery Corp., Harrison, N. J. The new unit comprises an electrically-driven ball bearing centrifugal pump, mounted with its motor on a fabricated steel bedplate, together with a Monobloc priming unit of the wet vacuum type, controlled by an electric pressure switch. The priming pump, or evacuator, is connected to the high spot of the suction volute and is sealed with clear water held in a reservoir built into the bedplate of the unit. The evacuator holder is connected across the main pump motor line at a point between the starting switch and the motor, so that in starting the motor the evacuator motor also starts.

Flow Meter. An electrically driven device for indicating and recording the flow of fluids, to be used with either a Venturi tube or orifice plate, has been announced by the Builders Iron Foundry, Providence, R. I. The new instrument, known as the Chronoflo meter, consists of a Telechron-driven contact device controlled by the height of the mercury column connected to the measuring tube and a Telechron-driven register recorder. This latter unit is in operation during the exact time that the mercury switch makes contact. The mercury switch is sensitive to small changes in the mercury level. The manufacturer states that a chart record reliable to one-twelfth the maximum rate of flow and a total flow register accurate to one-twentieth of the maximum flow is provided by the new meter.

Auto Patrol. A new model auto patrol, designated as model No. 7, is announced by the Caterpillar Tractor Co., Peoria, Ill. The new model retains the important features of the larger model No. 9, but weighs only 10,600 lb. The new machine has the same engine and transmission as the larger model.

Auto Truck. Mack Trucks, Inc., announces three new 6-cylinder trucks, designated as models BN, BX and BQ, covering a range of medium-capacity and heavy-duty, high-speed service. All are characterized by a setback front axle, resulting in better load distribution and contributing to tire mileage and ease of handling.

New Publications

Fire Hydrants. A 6-page folder describing a new type of fire hydrant has been published by the Automatic Cone Valve Co., Mattoon, Ill. The hydrant is so designed that it can be completely disassembled, head removed, valve seat removed, main valve removed, all without shutting off pressure. The disassembly is accomplished by a special device, which includes a gate valve, that is attached to the top of the barrel in place of the nozzle head when repairs are necessary. The manufacturer claims that no gate valve in the hydrant lead is necessary.

Cast Iron Pipe. A handbook of Anthony Joint cast-iron pipe and fittings has been published by the United States Pipe & Foundry Co., Burlington, N. J. The Anthony joint is a bolted joint using a clamp ring engaging the back of the pipe bell and a follower ring which forces a rubber gasket into the joint. The dimensions and weights of Anthony-joint pipe, from 3 in. to 24 in. in diameter, and of various types of special castings are tabulated.

Jet Condenser. A description of the jet condensers and auxiliaries for vacuum processes, manufactured by the Pennsylvania Pump & Compressor Co., Easton, Pa., is contained in a pamphlet recently put out by the company. The condenser effects condensation of steam by direct contact with cold circulating water. As more generally employed, it may be used as a barometric condenser or self-draining type, or as a low level condenser. Among the auxiliaries described are vacuum pumps, dry vacuum pumps, steam jet vacuum pumps and circulating pumps.

Cement Lined Pipe. A 20-page pamphlet giving the results of tests made on their product at the University of Illinois has been published by the Naylor Pipe Co., 1230 E. 92d St., Chicago, Ill. The new Naylor Pipe is of steel, spiral welded, protected on the outside by a layer of gunite and lined on the inside with a coating of cement mortar applied centrifugally. The tests made included tests on the structural strength of the steel pipe without the coating and also tests to determine the suitability of the lined and gunite-coated pipe for waterworks service.

Gas Meters. The rotary displacement meter, of two-impeller type, for measuring gas volumes, is described in a 12-page pamphlet published by Roots-Connersville-Wilbraham, Connersville, Ind. In addition to a discussion of the method of operation of the rotary displacement meter, the bulletin describes a recording gage which makes a continuous record of the pressure, volume and temperature of the gas being measured. Centrifugal blowers and compressors manufactured by the same company are described in another pamphlet of four pages.

Business Side of Construction

September Highway Awards Heaviest of Year

HIGHWAY CONSTRUCTION awards during September were the highest for the year, averaging $12,300,000 per week, as compared with $7,500,000 for August and $8,800,000 for June, the second high month. Road contracts averaged $7,400,000 in September, 1931. All heavy engineering construction contracts reported for September (five weeks) amounted to $114,487,000, of which $100,972,000 represents public works. Federal contracts were rather low, totaling $23,353,000. Private work amounted to $13,515,000.

The unseasonal activity in highway construction is due to the federal aid emergency loan of $120,000,000 which must be actually spent by the various states by next June. This means that most of the work to be financed by the loan fund will be placed under contract this fall. Several states which have done little or no highway construction this year are now letting large contracts.

Geographical distribution of heavy engineering construction contracts reported in September, 1932, (five weeks) in thousands of dollars. Federal contracts are included in regular classifications, but are also shown separately as a matter of record. Below are shown weekly average contract awards, in millions of dollars, for various classes of work and for different sections of the country.

Cost Index Rises Again

Ever since passing a 16-year low point of 152.20 in June, the *Engineering News-Record* Cost Index has steadily risen, now standing at 159.16, as compared with 157.96 in September. The current increase is due to a stiffening in the price of lumber, one of the three basic commodities entering into the make-up of the index. Labor rates, steel and cement prices, as used in the index, showed no change over the previous month. The *ENR* Volume Index rose from 111 in August to 124 in September.

Cement Production

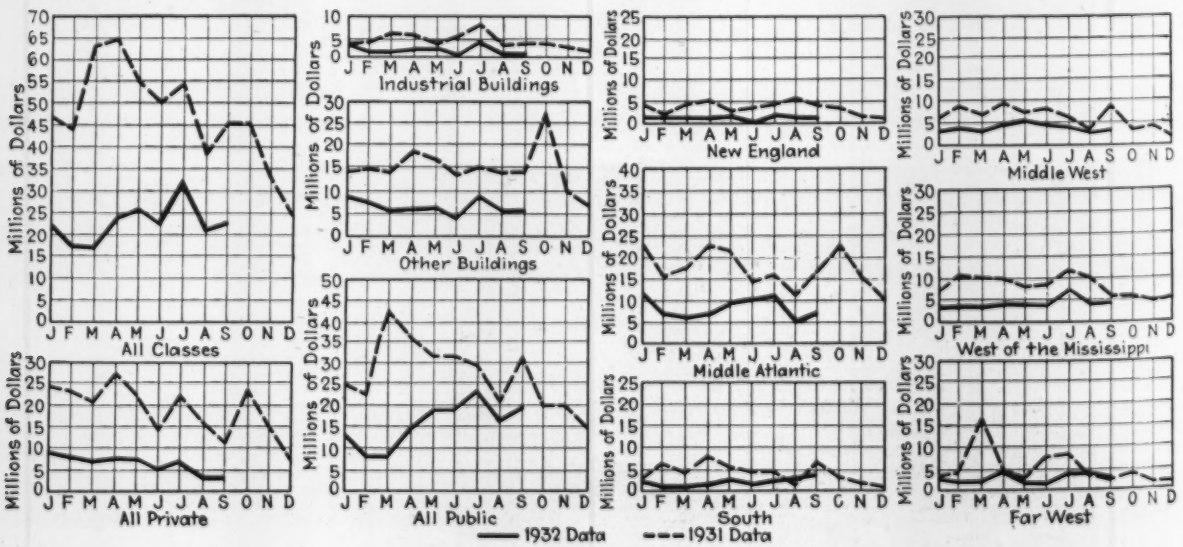
The portland cement industry in August, 1932, produced 7,835,000 bbl., shipped 10,968,000 bbl. from the mills, and had in stock at the end of the month 19,379,000 bbl., according to the U. S. Bureau of Mines. Production for August showed a decrease of 42.2 per cent, and shipments a decrease of 27.7 per cent, as compared

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN SEPTEMBER, 1932

Five Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Sept. 1932	United States Nine Months 1931	United States Nine Months 1932	Canada Sept., 1932
Waterworks	111	486	15	381	455	247	1,695	47,645	22,527	1,524
Sewers	61	1,247	1,090	548	288	.....	3,144	55,262	19,882	.....
Bridges, public	13	1,394	2	1,758	1,158	373	4,698	96,537	40,728	30
Earthwork and waterways	55	409	4,352	1,160	654	944	7,574	17,814	65,699	47
Streets and roads	3,058	14,240	12,527	9,505	15,415	7,002	61,747	454,390	281,271	375
Unclassified, public	17	1,129	89	34	78	97	1,444	64,487	34,215	284
Buildings, public	1,749	11,327	1,637	1,729	2,564	1,364	20,370	194,107	186,823	338
Total public	5,064	30,232	20,012	15,025	20,612	10,027	100,972	1,153,539	651,145	2,598
Federal government (included in above classifications)	871	7,416	6,805	2,079	2,843	3,339	23,353	223,295*	191,124	.....
Buildings, industrial	496	1,788	260	938	657	546	4,685	129,777	72,336	644
Buildings, commercial	595	3,478	455	1,762	501	250	7,041	427,663	139,634	110
Bridges, private	25	185	80	.....	.....	.....	290	9,909	3,694	.....
Earthwork, private	.....	.....	300	.....	.....	.....	300	.....	850	.....
Unclassified, private	135	570	40	56	483	215	1,499	224,226	47,035	148
Total private	1,251	6,021	835	2,756	1,641	1,011	13,515	811,575	263,549	902
September, 1932 (5 weeks)	**6,315**	**36,253**	**20,847**	**17,781**	**22,253**	**11,038**	**114,487**	.....	.....	**3,500**
August, 1932, (4 weeks)	5,558	20,624	11,019	12,500	18,177	13,726	81,634	.....	.....	7,068
September, 1931 (4 weeks)	12,998	71,699	20,780	39,080	22,478	9,921	176,956	.....	.....	15,444
Nine months, 1932	60,154	322,599	82,072	161,251	174,828	113,790	.....	.....	914,694	42,417
Nine months, 1931	147,725	728,936	197,926	314,507	324,896	251,034	.....	1,965,114	.....	91,302

* Not included in other classifications.



with August, 1931. Following are the percentages of production to capacity for several months: August, 1932, 34.2; August, 1931, 60.2; July, 1932, 33.4; June, 1932, 35.7; May, 1932, 30.2. Current stocks on hand at the mills are the lowest of the past three years.

Lumber Industry Improves

During the past four weeks, lumber orders received at the sawmills have increased appreciably over the record of previous weeks of 1932, according to the National Lumber Manufacturers Association. During the week ended September 17, orders were received for 188,291 M. f.b.m., the highest week of the year. To date the average weekly orders have been 139,275 M. f.b.m. The volume of orders, though encouraging, is not heavy enough to warrant an increase in production, in view of the excessive stocks on hand. Considerable lumber is in demand for industrial building, especially for textile plants in the South. Small house construction is reported to be the chief source of demand in the Central West. Public works construction is responsible for considerable lumber orders, including demands for form lumber. Sash and door manufacturers and shingle producers are reporting increased demands. The market for oak and maple flooring is reported to be improving.

Steel Upturn Slow

Based on the low August production, the steel industry enjoyed an upturn in September, though probably not as great as had been expected. Output towards the last of the month reached about 18 per cent of capacity. Structural steel was an important factor in production, though interest in rails increased lately following two loans by the Reconstruction Finance Corp. Prices have remained fairly firm, though concessions have not been entirely eliminated.

Labor Notes

Few changes in wage rates or labor disturbances were reported during the month. The strike on the new $8,000,000 Pittsburgh post office, which had tied up work for ten weeks, was finally settled. Controversy between the employers and hoist operators was responsible for the strike, the hoistmen claiming the right to place union operators on sand and gravel unloading operations, a point which was finally conceded to them.

Employment on Increase—A nation-wide increase of one-half of one per cent during August, as compared with June, in employment in sixteen major industrial groups was announced by the U. S. Department of Labor. This is the first time the decrease in employment has been checked for two years.

New York Highways—A recent report from Albany states there are 14,628 persons engaged in highway building throughout the state, 9,930 of which are in the employ of contractors.

Federal Buildings—Federal building operations at present are employing 400,000, according to Ferry K. Heath, assistant Secretary of the Treasury, of which 100,000 are working directly on the job and 300,000 others are in fabrication plants.

Pennsylvania Highways—Workers on Pennsylvania highways now total 38,454, of which 5,256 are working for contractors.

Missouri River Improvements—More than 20,000 men will be employed on Missouri River improvement projects by winter, according to Capt. Theo. Wyman, Jr., district engineer.

Ironworkers Oppose Wage Cuts—The International Association of Bridge, Structural & Ornamental Iron Workers passed a resolution at their annual convention in St. Louis condemning further wage cuts and authorizing union officials to oppose any proposed reductions.

Cincinnati—A minimum wage of 40c. and a 40-hour week will be specified in the contract for extensive water main extensions.

Montreal—Approval by the Provincial government of the city's sewer program will provide work for 10,000 throughout the winter.

St. Louis—Slight improvement noted in construction employment. Major street improvements, post office, municipal auditorium and Negro city hospital getting under way.

Los Angeles—Work on Los Angeles harbor breakwater and Los Angeles Aqueduct will be under way shortly, which should relieve unemployment situation. Driving of first tunnel for the aqueduct will commence within 60 days, according to reports.

Atlanta—Outlook for employment in building trades this winter discouraging.

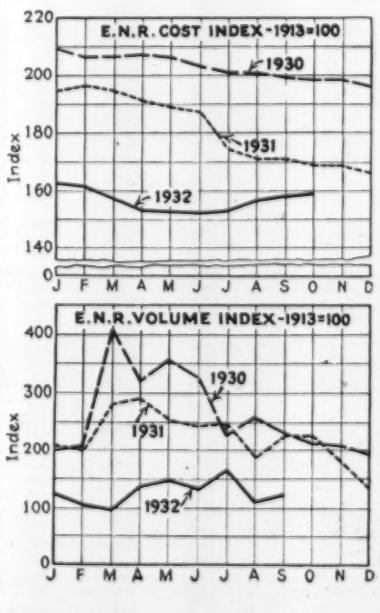
San Francisco—Directors of Golden Gate bridge project have adopted wage scale set by wage board some time ago. This wage scale was reduced 20 per cent by the San Francisco Builder's Exchange, the reduced rates being prevalent in the city at present.

Denver—Labor officials report 85 per cent of building trades workers unemployed.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta.....	$0.75@1.12½	$0.40@.90	$0.60@1.25	.....	$0.60@1.25	$0.25	$0.20@.25
Baltimore...	1.00	.80@.90	1.00@1.37½	$0.65	1.00@1.25	.40	.30
Birmingham	.75@.87½	.60	.75	.....	.75	.25	.20@.30
Boston.....	.90@1.30	.80@1.17½	1.00@1.37½	.75@1.07½	1.00@1.37½	.45@.70	.40@.70
Cincinnati..	.90@1.27½	.50@1.02½	1.07½	1.07½	1.06¼@1.20	.70	.40@.45
Chicago....	1.37½	1.31¼	1.31¼	1.31¼	1.35	.82½	.50@.82
Cleveland...	.90@1.37½	.87½@1.12½	.90@1.12½	1.00	.90@1.06¼	.56¼	.30@.72
Dallas.....	.62½	.50	.50	.50	.50	.25	.25@.35
Denver.....	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.31¼@.50
Detroit.....	.75@1.50	.55@.80	1.25	1.25	1.25	.70	.30@.50
Kansas City	1.30	1.12½	1.12½	1.06	1.12½	.82½	.35@.40
Los Angeles.	.62½	.50	.625	.625	.625	.50	.35@.50
Minneapolis	.90@1.00	.75	.75	.....	.90	.50	.40@.50
New Orleans	.60@.80	.40@.50	.80@1.12½	.90	.80@1.12½	.50	.15@.20
New York..	1.50@1.65	1.25@1.40	1.50@1.65	1.50	1.65	.81¼@1.00	.50@.75
Philadelphia	1.00@1.25	.60@.90	1.00	.75	1.00	.30@.40	.20@.30
Pittsburgh..	.60@1.50	.60@1.25	.60@1.37½	1.00@?.18½	.60@1.37½	.50	.40@.70
St. Louis...	1.50	1.25	1.35@1.47	1.25	1.47	1.00	.35@.78¾
San Francisco	1.10	.90	.90	1.00	1.00	.62½	.50@.62½
Seattle.....	.75@1.20	.50@.90	1.00	.90	1.10	.66	.40@.50
Montreal...	.75	.60	.55	.....	.70	.45	.25@.30

Construction Cost and Volume Index Numbers



The Cost Index maintained the rising trend started last June, the October Index standing at 159.16, as compared with 157.96 in September and 152.20 in June, the lowest since December, 1916. The current rise is due to a strengthening in lumber prices. The Volume Index for September is 124, as compared with 111 for the previous month.

E.N.-R. Cost		E.N.-R. Volume	
October, 1932	**159.16**	**Sept., 1932**	**124**
September, 1932	157.96	August, 1932	111
October, 1931	169.78	September, 1931	225
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 average	100.00		
1931		1931	
January	194.48	January	208
February	196.61	February	198
March	194.51	March	278
April	191.63	April	289
May	189.33	May	251
June	187.23	June	243
July	174.37	July	248
August	171.38	August	187
September	171.40	September	225
October	169.78	October	229
November	169.28	November	180
December	166.23	December	133
1932		1932	
January	162.48	January	121
February	161.82	February	105
March	157.24	March	97
April	153.12	April	135
May	152.78	May	149
June	152.20	June	131
July	153.36	July	166
August	156.80	August	111
September	157.96	September	124
October	159.16		

Current Prices of Construction Materials

Building Materials

PORTLAND CEMENT — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

	F.o.b.	Delivered		F.o.b.	Delivered
Atlanta	$2.30	$2.85	Kansas City	$1.60	$1.70
Baltimore	....	2.03	Los Angeles	2.10	2.10
Birmingham	2.02	2.12	Minneapolis	2.10	2.25
Boston	1.58	1.68	Montreal	1.70	....
Chicago	1.60	1.95	New Orleans	1.86	2.20
Cincinnati	1.52	1.64	New York	1.59	1.70
Cleveland	1.25	1.50	Philadelphia	1.84	1.94
Dallas	2.23	2.38	Pittsburgh	1.68	1.78
Denver	....	2.40	St. Louis	1.64	1.95
Detroit	1.47	?.80	San Francisco	2.05	....
			Seattle	2.55	2.70

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

Alpena, Mich	$1.20	Mason City, Ia	$1.35
Buffington, Ind	1.25	Norfolk, Va	1.61
Dallas, Tex	1.75	Northampton, Pa	1.40
Hannibal, Mo	1.25	North Birmingham, Ala	1.60
Hudson, N. Y	1.50	Richard City, Tenn	1.70
Independence, Kan	1.35	Steelton, Minn	1.45
Ironton, Ohio	1.06	Universal, Pa	1.21
Iola, Kan	1.35	Waco, Tex	1.75
La Salle, Ill	1.25	Wyandotte, Mich	1.20
Limedale, Ind	1.25		

SAND AND GRAVEL — Per ton, carload lots, gravel, size ¾-in.:

	Gravel		Sand	
	F.o.b.	Delivered	F.o.b	Delivered
Atlanta	$1.95	$2.75	$1.50	$2.50
Baltimore	....	2.55	....	2.08
Birmingham, per cu.yd	....	3.00	....	2.40
Boston	1.40	1.65	.90	1.15
Chicago, per cu.yd	....	2.25	....	2.25
Cincinnati	1.30	1.60	1.05	1.35
Cleveland	....	2.00	....	2.00
Dallas, per cu.yd	1.00	1.50	1.00	1.50
Denver, per cu.yd	1.75	1.85	1.15	1.20
Detroit	.50	1.45	.72	1.50
Kansas City	.75	....	.60	....
Los Angeles	1.35	1.45	.85	1.00
Minneapolis	....	1.60	....	.65
Montreal	1.50	....	1.25	....
New Orleans	1.50	2.50*	1.20	2.00*
New York, per cu.yd	1.60	3.25	1.00	2.00
Philadelphia	....	1.66	....	1.38
Pittsburgh	....	1.20	....	1.40
St. Louis	.75	1.15	.75	1.15
San Francisco	1.75	....	1.75	....
Seattle, per cu.yd	1.75	....	1.75	....

*Cu.yd.

CRUSHED STONE — Per ton, size 1½-in., carload lots, limestone:

	F.o.b.	Delivered
Atlanta	$1.95	$2.75
Baltimore	....	2.60
Birmingham	.80	1.05
Boston	1.40	1.65
Chicago, per cu.yd, 2,500 lb	....	2.25
Cincinnati	1.65	1.85
Cleveland	....	2.00
Dallas, per cu.yd., 2,500 lb	1.90	....
Denver, granite, per cu.yd., 2,700 lb	....	2.50
Detroit	1.09	1.95
Kansas City	1.25	....
Los Angeles	1.35	1.45
Minneapolis	....	1.60
Montreal	1.35	....
New York, per cu.yd., 2,800@3,000 lb	1.60	3.25
Philadelphia	....	2.00
Pittsburgh	....	2.25
St. Louis	1.35	1.65
San Francisco, trap rock	1.65	....
Seattle, per cu.yd., 3,000 lb	1.10	....

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Slag Sand
Birmingham	$0.90	$1.15	$2.05	$0.55
Buffalo	1.35	1.35	2.25	1.25
Cleveland	1.70	1.70	....	1.35
Toledo	1.20	1.20	1.20	1.10
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown	1.10	1.20	2.00	.75

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Birmingham (5x8x12)	$0.084	Kansas City	$0.18
Boston	.15	Los Angeles	.15
Brooklyn and Queens	.12	Minneapolis	.09
Chicago	.175	Montreal	.14
Cleveland	.165	New Orleans	.165
Denver	.15	Philadelphia	.15
Detroit	.08	Pittsburgh	.14
		St. Louis	.14

READY MIXED CONCRETE—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

Atlanta	$7.75	Los Angeles	$5.00
Birmingham	4.90	Minneapolis	6.00
Boston	6.50	New Orleans	6.20
Cincinnati	7.10	New York (Manhattan)	8.50
Dallas	6.00	Philadelphia	5.98
Detroit 1:2½:5	5.90	Pittsburgh	5.75
Kansas City	7.50	St.Louis	6.15
		Seattle	5.35

HOLLOW TILE—Building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.10	.14	.20	.22	.30
Birmingham	.089	.122	.167	.219	.25
Boston (at plant)	.075	.11	.14	.20	.30
Chicago	.0484	.063	.09	.1179	.13
Cincinnati	.06815	....	....	.165	....
Cleveland	.048	.066	.09	.117	.13
Dallas	.084	.121	.159	.177	.234
Denver	.085	.135	.175	.19	.25
Detroit	.0505	.065	.0947	.1175	.1305
Kansas City	.0735	.092	.15	.1777	.20725
Los Angeles	.09425	.134	.188	.2325	.3115
Minneapolis	.0635	.09395	.1232	.13425	.2103
New Orleans	.085	.115	.16	.225	.255
New York	.075	.1164	.145	....	....
Perth Amboy	....	....	....	.2388*	.2956*
Philadelphia	.065	.093	.14	.175	.195
Pittsburgh	.0435	.065	.088	.1165	.126
St. Louis	.062	.088	.118	.16	.20
San Francisco	.0765	.105	.1765	....	....
Seattle	.085	.115	.18	....	....

*At plant. (Load-bearing tile).

BRICK — Prices per thousand in carload lots, as follows:

	Common Backing		Paving F.o.b.
	F.o.b.	Delivered	3¾x8¼x4-in
Atlanta	$8.50	$14.00	$32.00
Baltimore	....	12.00	42.00†
Birmingham	10.00	12.50	25.00
Boston	12.00	16.00	48.00
Chicago	....	9.00	32.00
Cincinnati	13.50	16.00	36.50
Cleveland	12.00	14.00	33.00
Dallas	....	12.00	25.00†
Denver	13.00	....	40.00
Detroit	11.50	12.50	25.00
Kansas City	12.00	13.00	33.00
Los Angeles	8.00	8.50	....
Minneapolis	....	7.50	....
Montreal	21.50	....	....
New Orleans	10.50	14.50	40.00
New York	9.50	11.50	45.00
Philadelphia	....	13.00	40.00
Pittsburgh	11.00	13.00	35.00
St. Louis	....	12.00	28.00
San Francisco	14.00	....	45.00*
Seattle	12.00	14.00	55.00†

*2½x8½x4 in. †3½x8½x1 in.

LIME — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

	Hydrated				Common Lump,
	Finishing		Common		
	F.o.b.	Delivered	F.o.b.	Delivered	F.o.b. Delivered
Atlanta	‡13.50	$18.00	$11.50	$15.50	.... $2.50
Baltimore	....	20.00	....	13.00	....
Birmingham	21.00	....	12.00	....	1.65 ....
Boston	17.00	19.00	14.00	16.00	$2.35* 3.25*
Chicago	....	20.00	....	14.00	.... 2.75
Cincinnati	11.00	12.00	9.40	10.40	....
Cleveland	10.50	14.00	8.50	12.00	.... 2.50
Dallas	....	20.00	....	....	.... 2.50
Denver	....	30.00	....	22.00	.... 2.85*
Detroit	9.25	14.00	7.25	12.00	....
Kansas City	....	22.00	....	....	.... 2.75
Los Angeles	24.00	26.00	17.00	18.00	.... 2.00
Minneapolis	....	21.00	....	19.00	.... 1.70
Montreal	....	18.00	12.00	13.00	....
New Orleans	14.75	22.50	11.50	14.00	1.60 1.95
New York	10.70	14.00	8.60	12.50	2.25* 3.15*
Philadelphia	11.50	15.39	9.90	13.49	.... 3.18
Pittsburgh	11.50	13.00	10.75	12.25	1.85 2.35
St. Louis	....	.45‡	....	.40‡	.... 2.75
San Francisco	19.00	19.00	19.00	19.00	.... 1.85
Seattle	....	32.00	....	24.00	.... 2.80

*Per 280-lb. bbl. (net.) ‡Per sack.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:
New York:* Rustic buff, $1.48; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.48.
Boston: Rustic buff, $1.43; Standard, $1.56; Selected buff, $1.70.
Pittsburgh: Rustic buff, $1.56; Standard, $1.28 at quarry; Selected buff, $1.86.
Philadelphia: Sel. buff, $1.65; Sel. gray, $1.55; Standard, $1.55; Standard gray, $1.45; Rustic buff, $1.35.
Atlanta: Standard, $1.26‡
*F.o.b. Bedford, freight allowed to N. Y.

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square:

No. 1 Clear	$8.25@$9.50
No. 1 Ribbon	6.75@ 7.50
Medium Clear	7.25@ 8.00

Road and Paving Materials

PAVING STONE — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Birmingham	76.25 per M.
Boston	90.00 per M.
Chicago, 5 in	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	95.00 per M.
Dallas	25.00 per M.
Detroit, 5 in	2.80 per sq.yd.
Kansas City	3.00 per sq.yd.
Minneapolis, 4½ in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in	135.00 per M.
Philadelphia, 4x10x5	115.00 per M.
Pittsburgh	115.00 per M.
St. Louis, 5 in	2.90 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING — Prices f.o.b., in carload lots:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.10
Chicago	3½	12	1.90
Kansas City	3½	16	2.65
Minneapolis	3½	16	2.25
Montreal	3½	16	2.63
New York	3½	14	1.90
Philadelphia	3½	16	2.02
St. Louis	3½	16	2.10

CURBING—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

Atlanta	$0.41	New York	$0.62
Birmingham	.50	Philadelphia (6x20 dressed)	1.40
Boston	.70	Pittsburgh	.80
Dallas	.60	St. Louis	.65@.70
Detroit	.45		

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$18.40	$14.40
Baltimore (f.o.b. refinery)	16.00	12.00
Birmingham	.....	11.00
Boston	18.00	14.00
Chicago	22.50	15.50
Cincinnati (f.o.b. refinery)	.....	8.00
Cleveland	18.25	14.50
Dallas	.....	27.00
Denver	27.50	.....
Detroit	16.80	12.43
Kansas City (f.o.b. refinery)	16.00	.....
Los Angeles (f.o.b. refinery)	18.00	12.00
Maurer, N. J. (Bermudez)	.....	26.00
Maurer, N. J. (Trinidad)	.....	22.00
Minneapolis (f.o.b. Twin Cities)	23.30	16.30
Montreal (f.o.b. factory)	17.00	13.00
New Orleans (f.o.b. refinery)	16.00	12.00
New York (f.o.b. refinery)	16.00	12.00
Philadelphia	17.00	11.00
Pittsburgh	25.00	16.00
St. Louis (f.o.b. refinery)	14.00	10.00
San Francisco (f.o.b. refinery)	16.00	10.00
Seattle (f.o.b. refinery)	23.00	17.00

LIQUID ASPHALT — Residual, hot application, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Atlanta	$0.06
Birmingham	.06
Boston	.055
Cincinnati	.075
Dallas	.05
Kansas City	.05
Los Angeles	.045
Montreal at (refinery)	.09
New York	.05
Philadelphia	.08
Pittsburgh	.05
St. Louis (at refinery)	.035

EMULSIFIED ASPHALT — For penetration and surface treatment, per gal.:

Boston, applied	$0.12
Cincinnati, f.o.b. refinery	.06
Los Angeles, applied	.11
Des Moines, applied	.12
New York, applied	.14
Philadelphia, applied	.13
Pittsburgh f.o.b. refinery	.04@.06
St. Louis, applied	.12
Seattle, f.o.b. refinery	.055@.085

Iron and Steel

	Pittsburgh	Chicago	Birmingham	Cleveland
STRUCTURAL SHAPES AND PLATES, per 100 lb., base, carload lots	$1.60	$1.70	$1.75	$1.78
CONCRETE REINFORCING BARS, ¼ in., billet, per 100 lb., carload lots	1.60	1.65	1.75	1.50
SHEETS, per 100 lb., carload lots:				
Hot-rolled No. 10	1.55	1.65	1.85	.....
Hot-rolled annealed No. 24	2.15	2.30	2.35	.....
Galvanized No. 24	2.80	2.95	3.00	.....
TERNE PLATES, per package, I.C., 8-lb. coating, 20x28 in.	9.50	.....	.....	.....
RIVETS per 100 lb., ½ in., structural, carload lots	2.25	2.35	2.70	2.25
SHEETPILING, per 100 lb., base, carload lots	1.90	2.05	.....	.....
WIRE NAILS, per 100 lb., base, carload lots	1.95	2.00	2.40	1.95
HEAVY MELTING STEEL SCRAP, No. 1, per gross ton, at consuming point	9.75	6.75	7@7.50	7.00

TRIANGLE MESH—Plain, per 100 sq.ft., 4 in. x 4 in., in carload lots:

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
032	22	$0.94	$0.96
049	28	1.19	1.22
068	35	1.45	1.49
093	45	1.87	1.91
126	57	2.31	2.37
153	68	2.75	2.82
180	78	3.16	3.24
245	103	4.17	4.27
287	119	4.82	4.94
33[illegible]	138	5.59	5.73
395	160	6.48	6.64
036P	17	.71	.73
053P	24	1.01	1.03

TRIANGLE MESH—*Continued.*:

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
072P	31	1.27	1.30
097P	40	1.64	1.68
049R	24	1.01	1.03
067R	31	1.27	1.30
089R	40	1.64	1.68

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	25 c
Galvanized iron rigging and guy rope (add to list)	7½ c
Galvanized steel rigging and guy rope	12½ c
Plow steel round strand rope	40 c
"Special Steel" and extra strong cast steel, round strand rope	32½ c

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

EXPANDED METAL LATH—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

Atlanta	$20.00*	Los Angeles	$17.00
Birmingham	17.00	New Orleans	20.50
Boston	15.00	New York	13.50
Chicago	10.60	Philadelphia	13.50
Cincinnati	11.00	Pittsburgh	13.50
Dallas	16.50	St. Louis	19.00*
Detroit	18.00*	San Francisco	17.00*
Kansas City	17.00*	Seattle	19.00

*Delivered.

STEEL FREIGHT RATES — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

Atlanta, 36,000 lb.	$0.60	Detroit	$0.285
Baltimore	.29	Kansas City	.59
Birmingham	.60	New Orleans, 36,000 lb.	.69
Boston	.42	New York, 36,000 lb.	.35
Buffalo	.255	Pacific Coast, 60,000 lb.	1.17*
Chicago	.36	Philadelphia	.31
Cincinnati	.285	St. Louis	.41
Cleveland	.205	St. Paul	.60
Denver	.92	* All rail.	

Railway Materials and Supplies

STEEL RAILS—Standard rails have been $43.00 per gross ton since Sept., 1922, at which time the price was $40.00; other rails, per gross ton, f.o.b., as follows:

	Pittsburgh	Birmingham	Chicago
Light rails	$32.00	$32.00	$34.00
Re-rolled rails	21@23	.....	27.00

RAILWAY TIES — Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.00	.....
	Pine, untreated	.90	.....
	Pine, creosoted	1.40	.....
New York	Long-leaf sap pine, untreated	.90	$1.10
	Dense yellow pine, untreated	.65	.85
Birmingham	White oak, untreated	.75	.95
	White oak, creosoted	1.25	1.45
	Southern pine, untreated	.35	.80
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
Los Angeles	Fir, untreated	.47	.....
	Fir, creosoted	1.20	.....
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
St. Louis	White oak, untreated	.75	1.25
	Red oak, untreated	.70	1.05
	Red oak, creosoted	105	1.70
	Sap pine or cypress, untreated	.60	1.00
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

TRACK SUPPLIES — Prices per 100 lb., f.o.b., for carload lots:

	Pittsburgh	Birmingham	Chicago
Angle bars	$2.75	$2.75	$2.75
Standard spikes	2.60	2.60	2.60
Tie plates	1.85	1.85	1.85
Track bolts	3.50	3.50	3.50

Pipe

WROUGHT STEEL PIPE — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Atlanta	44%	36.5%	42%	34%
Boston	55.5%	42.25%	51.35%	40.1%
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
Denver	44.5%	32%	41%	28.5%
New York	56.14%	43.6%	52.72%	40.18%
Philadelphia	57.28%	44.68%	53.68%	41.80%
Pittsburgh	64%	52.5%	61%	49.5%
St. Louis	51%	38%	48%	35%

Current Prices of Construction Materials

Pipe—Continued

CAST-IRON PIPE — Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

	4-In.	6-In. and Over
Atlanta	$37.50	$34.50
Boston	39.00	36.00
Birmingham (Base)	33.00	30.00
Burlington (Base)	33.00	30.00
Chicago	41.50	38.50
Dallas	45.50	42.50
Los Angeles	41.50	38.50
New York	36.50	33.50
Philadelphia	35.00	32.00
Pittsburgh	39.50	36.50
St. Louis	40.50	37.50
San Francisco	41.50	38.50

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.125	$0.21	$0.385	.....	$1.40.	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.16	.25	.50	1.25	2.10	4.40	5.50
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.108	.21	.324	1.05	1.755	3.528	5.4325
Cleveland	.135	.21	.405	1.125	2.025	4.824	7.38
Dallas	.23	.325	.586	1.106	1.95	3.68	5.00
Denver	.16	.23	.414	.816	1.44	.....	.....
Detroit	.0855	.....	.2625	.....	1.90	3.80	.....
Kansas City	.21	.335	.52	1.00	1.90	3.80	.....
Los Angeles(f.o.b.)	.2175	.2825	.5085	1.1865	2.034	3.69	.....
Minneapolis	.18	.23	.46	1.20	1.85	3.20	4.26
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.13	.21	.42	1.15	2.10	.....	.....
Philadelphia	.081	.126	.243	.65	1.17	2.376	4.615
Pittsburgh	.09	.18	.27	.62	1.22	2.45	3.68
St. Louis	.112	.210	.378	.945	1.62	3.20	4.40
San Francisco	.175	.25	.45	1.05	1.80	3.00	4.50
Seattle	.21	.30	.54	1.26	2.16	3.60	5.50

CLAY DRAIN TILE—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

Atlanta	$50.00	Los Angeles	$60.00
Birmingham	50.00	New Orleans	40.00
Boston	40.00	New York	35.00
Chicago	40.00	Philadelphia	36.00
Dallas	65.00	Pittsburgh	80.00
Denver	75.00	St. Louis	40.00
Detroit	40.00	San Francisco	67.50
Kansas City	70.00	Seattle	42.50

Miscellaneous

LINSEED OIL—Raw, in 4-bbl. lots, per lb., f.o.b.:

Atlanta	$0.065	Minneapolis	$0.069
Birmingham	.066	Montreal (per gal.)	.50
Boston (per gal.)	.50	New York	.067
Dallas	.073	Philadelphia	.064
Denver	.0893	Seattle	.075
Kansas City (per gal.)	.51	St Louis	.073
Los Angeles	.0813	San Francisco (del)	.1125

WHITE LEAD—In oil, per 100 lb. keg., f.o.b.:

Atlanta	$12.50	Montreal	$ 8.20
Birmingham	12.50	New Orleans	11.00
Boston	11.50	New York	12.00
Dallas	13.00	Philadelphia	9.50
Kansas City	12.50	Seattle	11.00
Los Ange'es	11.50	St. Louis	12.00

Note: Both white and red lead, dry, same prices as foregoing; red in oil, $1.50 higher

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb	$1.75
Calcium chloride, 77-80%, flaked, in 400-lb. drums, f.o.b. works, per ton	21.00
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, in drums, f.o.b. works, per 100 lb	1.35
Soda ash, 58%, in bags, per 100 lb	1.17½
Sulphate of aluminum, in bags, per 100 lb	1.25
Sulphate of copper, in bbl., per 100 lb	3.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¾-*in.*, 6-ft.; 1-in.; ⅞-*in.*, 4-ft., 5-in.; *1-in.*, 3-ft., 8-in.; *1¼-in.*, 2-ft., 5-in.; *1½-in.*, 1-ft., 8-in. Following prices are per lb. for ¾-in. and larger, delivered in 1,200 ft. coils:

Atlanta	$0.16	Kansas City	$0.21
Baltimore	.225	Los Angeles	.1725
Birmingham	.20	Minneapolis	.175
Boston	.16	Montreal	.1625
Chicago	.175	New Orleans	.165
Cincinnati (f.o.b.)	.21	New York	.165
Cleveland	.21	Philadelphia	.15
Dallas	.25	St. Louis	.155
Denver	.18	San Francisco	.175
Detroit	.185	Seattle	.155

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.20

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.65

PREPARED ROOFING—Per square, f.o.b., in carload lots:

	Single Shingles*	Strip Shingles†	Rolls‡
Atlanta	$5.85	$6.25	$2.05
Boston	6.25	6.00	2.50
Dallas	5.25	4.50	2.25
Detroit	6.25	6.50	2.00
Montreal	6.40	6.20	2.68
New Orleans	5.60	5.50	2.00
New York	6.50	6.25	2.50
Philadelphia	4.00	3.80	1.45
Seattle	.....	6.60	2.55
St. Louis	4.29	4.06	1.53

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate surfaced, in rolls weighing 85 to 90 lb. †4 in 1, hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—In carload lots, f.o.b.:

	Asphalt Felt, per 100 Lb.	Tar Felt, per 100 Lb.	Asphalt Coating, per Gal.	Tar Pitch,* per Ton
Atlanta	$44.50†	$44.50†	$0.45	$44.50
Boston	2.40	2.40	0.33	28.00
Dallas	3.25	3.50	1.00	42.00
Denver	2.00	2.00	.90	18.00
Montreal	2.62‡	2.02‡	1.40	32.60
New Orleans	.....	2.50	.....	22.50
New York	2.40	2.40	.34½	28.00
Philadelphia	2.25	2.25	.33	20.00
Seattle	2.40	2.40	.55	27.90

*In 350 lb. barrels. †Per ton. ‡Per roll.

WINDOW GLASS—Discounts from latest jobbers list, dated Sept. 15, 1928 for sizes above first three brackets:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
Atlanta	85%	85%	85%	85%
Birmingham	89%	91%	89%	91%
Boston	87%	89%	87%	89%
Dallas	85%	87.5%	87.5%	89.5%
Denver	84@5%	86@5%	84@5%	86@5%
Kansas City	90@5%	90@5%	90@5%	90@5%
New York	87%	89%	87%	89%
Philadelphia	88%	90%	88%	90%
Pittsburgh	87%	89%	87%	89%
Seattle	90@10%	90@20%	90@10%	90@20%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.215	$0.2375	Los Angeles	$0.1725	$0.1925
Baltimore	.21	.225	Minneapolis	.18	.195
Birmingham	.13	.1525	Montreal	.1675	.1925
Boston	.225	.25	New Orleans	.195	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati (f.o.b.)	.22	.245	Philadelphia	.215	.24
Dallas	.28	.30	St. Louis	.1925	.2175
Denver	.19*	.21*	San Francisco	.1575	.1825
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*F.o.b Louviers.

Lumber

LUMBER—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

PINE

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b.
Atlanta	$14.00	.....	$15.00	.....	$35.00	.....	$45.00
Baltimore	.....	$46.00	.....	.....	.....	$70.00	70.00
Birmingham	.....	15.00	.....	$15.00	.....	18.00	25.00
Boston	28.00	33.00	30.00	35.00	40.00	45.00	70.00
Chicago	.....	.....	.....	.....	.....	62.50	.....
Cincinnati	.....	28.00	.....	28.00	.....	35.00	35.00
Cleveland	30.00	38.00	32.00	40.00	46.00	54.00	.....
Dallas	.....	32.50	.....	32.50	.....	47.50	55.00
Denver	.....	31.00	.....	33.00	.....	45.00	.....
Detroit	29.00	29.00	30.00	30.00	32.00	32.00	45.00
Kansas City	24.00	.....	21.00	.....	46.00	.....	.....
Minneapolis	.....	31.00	.....	31.00	.....	34.00	.....
Montreal	44.00	.....	45.00	.....	30.00	.....	.....
New Orleans	.....	15.50	.....	16.50	.....	52.00	.....
New York	22.50	23.50	23.50	24.50	47.50	59.40	47.50
Phil. No. 2 (com.)	18.00	22.00	19.00	23.00	29.00	33.00	48.00
Pittsburgh	20.00	33.00	20.00	33.00	32.00	39.00	46.00
St. Louis	23.00	28.00	23.50	28.50	46.00	51.00	44.00

FIR

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b.
Baltimore	.....	$43.00	.....	.....	.....	$46.00	$46.00
Boston	$26.00	31.00	$28.00	$33.00	$31.00	36.00	48.00
Chicago	.....	.....	.....	.....	.....	44.52	.....
Cincinnati	.....	.....	.....	.....	.....	42.50	42.50
Cleveland	30.00	38.00	32.00	40.00	46.00	54.00	.....
Dallas	30.00	.....	29.00	.....	38.00	.....	36.75
Denver	.....	34.00	.....	36.00	.....	47.00	.....
Detroit	.....	.....	.....	.....	30.00	30.00	45.00
Kansas City	30.00	.....	33.00	.....	42.00	.....	39.00
Los Angeles	39.00	41.50	39.00	41.50	43.00	45.50	40.00
Minneapolis	.....	31.00	.....	31.50	.....	36.00	.....
New Orleans	.....	20.00	.....	20.00	.....	42.50	.....
New York	21.50	22.50	22.50	23.50	25.50	26.50	26.50
Philadelphia	.....	.....	.....	.....	.....	28.00	30.00
Pittsburgh	.....	.....	.....	.....	58.00	63.00	48.00
St. Louis	30.00	35.00	30.00	35.00	32.00	37.00	32.00
San Francisco	.....	30.00	.....	30.00	.....	32.00	.....
Seattle	9.00	11.00	11.00	13.00	12.00	14.00	14.00

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.193
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442